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Convertible Bonds

A Guide

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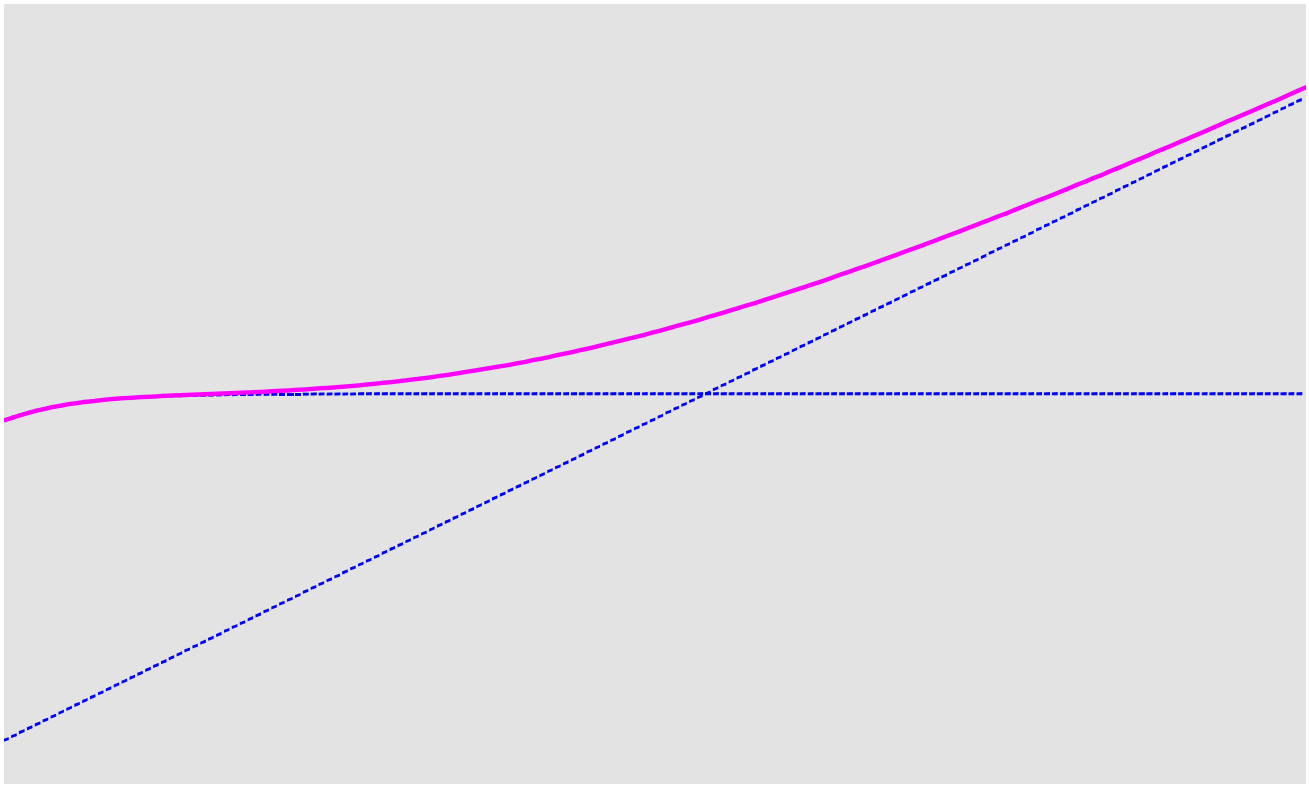

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Introduction

The focus of this guide is the Europe convertibles market. Much of the content is applicable to convertibles markets in general, however. We outline practical and theoretical aspects of the market in seven sections. There is also a glossary of terms.

The basics

Using a hypothetical example, the key features of a typical convertible issue are introduced and their significance explained. The interpretation of a convertible as a derivative instrument is also discussed.

Convertibles bonds: investor perspective

From an equity investor's point of view, buying a convertible bond resembles the purchase of a certain number of shares, the purchase of downside protection and (sometimes) the purchase of additional yield. For the fixed-income investor a convertible bond combines the characteristics of a bond with an element of equity participation.

Convertible bonds: hedge fund perspective

Hedge funds typically neutralise exposure to one or more of the variables that influence a convertible's value. We pay particular attention to the ways in which credit exposure can be mitigated.

Convertible bonds: issuer perspective

We look at some of the theoretical and practical considerations facing a potential issuer of equity linked paper.

Convertible structures

At issue a convertible can be structured with varying degrees of equity and bond exposure. We look at a number of structures including the incongruously named 'mandatory convertible'.

Pitfalls and protections

Appreciating the importance of prospectus detail is crucial in convertible analysis; we identify some protection issues.

Pricing models

We present a brief intuitive description of the nature of the theoretical models most frequently employed to value convertible bonds.

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Table of Contents

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Index of Tables

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Basics

- ➤ **Convertible bonds as hybrid securities**
- ➤ **The 'vanilla' structure**
- ➤ **Terminology**
- ➤ **Convertibles as derivatives**
- ➤ **Convertible price sensitivities — the 'Greeks'**

Convertible bonds as hybrid securities

Convertible bonds are hybrid securities, part debt and part equity. They are corporate bonds that may be exchanged at the option of the holder for a fixed number of ordinary shares. Convertibles are usually redeemable in cash at maturity and pay a fixed coupon. At maturity, a convertible is worth the greater of its cash redemption value or the market value of the shares into which it has rights of conversion.

Convertibles benefit from some of the risk characteristics of fixed interest securities, having (as a minimum) their income and redemption features. This defensive quality combined with the prospect of participation in the event of share price strength is fundamental to the product's appeal.

It would be wrong to conclude that convertibles provide investors with unequivocal advantages over bonds or shares. Indeed, equities will typically outperform convertibles in a rising share price environment, while a company's straight debt is likely to fare less badly then its convertible debt in a falling share price environment. It is the uncertain nature of investment returns that lies at the core of the rationale for the convertible asset class, in our opinion.

To recap, convertible bonds offer the following:

- *Upside participation* in a rising equity market (thus outperforming straight debt).
- *Downside protection* in a declining equity market (thus outperforming straight equity).
- Possible *income advantage* to the underlying shares.
- Convertibles characteristically display greater volatility than straight debt, but less volatility than equity.

The 'vanilla' structure

As with other bonds, a convertible typically pays coupons and carries the promise of cash redemption at maturity. A convertible differs from straight debt in that the holder has the right to exchange the bond, usually at any time, for a predetermined number of the company's ordinary shares, without any extra payment.

On conversion, the investor renounces title to the corporate bond and any future income streams from it in favour of ownership of the predetermined number of shares.

Plain vanilla structures are rare, however, as most convertible bonds include call features. Below is an example of a simple callable convertible. The example is used to provide a glossary of terms useful in explaining and valuing convertibles bonds in general. We use a hypothetical convertible bond, the *Widgets Convertible EUR 4% 2007*. Figure 1 shows the terms of the bond at issue and figure 2 gives some details of the underlying share.

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Figure 1. Widgets 4% 2007 — Convertible Data at Issue	
Coupon	4%
Coupon Frequency	2 (semi-annual)
Issue Date	1 January 2002
First Coupon Date	1 July 2002
Maturity	1 January 2007
Nominal Value	Eur1000
Issue Price	100
Redemption Value	100
Conversion Ratio	10 shares per bond
Conversion Price	Eur100
Call Protection	Hard Call 3 years
	2 years; then 130% triggeer
Call Price	100
Put Feature	-
Issue Size	Eur300m

Source: Citigroup.

Figure 2. Widgets — Ordinary Share Data	
Stock Price	Eur80
Stock Volatility	25%
Dividend per Share	Eur2
Dividend Yield	2.5%

Source: Citigroup.

Figure 3 displays some characteristics of the convertible at issue, based on the data in figures 1 and 2.

Figure 3. Widgets 4% 2007 — Convertible Data at Issue	
Convertible Price	100
Parity	80
Premium	25%
Current/Running Yield	4%
Yield To Maturity	4%

Source: Citigroup.

The meaning of the terms employed in Figures 1, 2 and 3 are explained below.

Terminology

Name convention

Convertible bonds are usually identified by issuer name (Widgets), currency (EUR), coupon (4%) and maturity date 2007, although this may be abbreviated to issuer name, coupon and maturity.

Coupon

Coupons are the interest payments made on a bond by the issuer, fixed at issue. By convention the coupon is quoted as a percentage of the bond's nominal value. For the *Widgets Convertible EUR 4% 2007*, the coupon is 4% or €40 per bond of €1,000 nominal. As the *Widgets Convertible EUR 4% 2007* pays coupons semi-annually, the coupon will be paid in two instalments of €20 each in July and January.

Accrued interest

As with most bond markets convertibles observe a 'clean price' quotation convention. (French convertibles are exceptions; see below). When an investor buys a bond at a certain quoted price, he will actually pay an incremental sum if the settlement date falls between two coupon dates to take account of the accrual of coupon.

The interest accrued on the *Widgets Convertible EUR 4% 2007* in a contract with a settlement date of June 4, 154 days after the coupon date, would be calculated as follows:

*Accrued interest = (154/365)*4%*

Accrued interest = 1.688%

Thus an investor buying the bond at 100% would actually pay 101.688% after accrued interest.

Some bonds specify calculation of accrued interest with respect to a 30-day month and 360-day year.

French convertible bond prices are normally quoted in 'dirty price' format (inclusive of accrued interest) and 'price per bond' terms, not as a percentage of the nominal value. Thus the bond price will fall by the extent of the coupon, on the date it goes "xd", other things being equal. By convention the "xd" date for French convertibles is the payment date itself, not the last trading day for which settlement falls before the coupon payment date.

Maturity

The maturity date is the date on which the issuer is obliged to redeem unconverted bonds.

The *Widgets Convertible EUR 4% 2007* would mature on 1 January 2006 at 100% of its nominal value or €1,000 per bond. However, it would be rational for holders of the bonds to convert them prior to the final maturity date if the market value of the shares into which they convert exceeds the cash redemption value of the bond.

Nominal value

The nominal (or *face*) value of a bond is its unit size. *Widgets Convertible EUR 4% 2007* convertible bond has a nominal value of €1,000.

Many convertibles in Europe have a nominal value of 1,000 (in the relevant bond currency). Even though there are many exceptions to this rule, 'one bond' is sometimes used to mean '1,000 nominal'[1]. As described above, the convertible's price, issue price and redemption value are normally expressed as a percentage of the bond's nominal value; French convertibles are an exception to this rule, being quoted in unit form.

Issue price

When the issue price of the convertible is equal to the bond's nominal value, the convertible is said to have been 'issued at par'. The term 'par' is generally used to mean 100% of the face value of a bond. The Widgets Convertible EUR 4% 2007 was issued at par, as its issue price (€1,000) was equal to 100% of the convertible's nominal value.

If a bond is issued at a price below its nominal value, it is referred to as an '*original issue discount*' (OID) bond. Likewise, the term 'original issue premium' can be coined to describe those issued above par.

Market forces will cause the price of a convertible bond to deviate from its nominal or face value over its life.

Conversion price/conversion ratio

The price at which underlying shares are indirectly purchased, assuming conversion takes place and the convertible has been bought at par, is shown by the '*conversion price*'. The conversion ratio is the number of shares into which

[1] There is a lack of consistency in market nomenclature. Whereas 'fifty bonds' would mean 50,000 nominal (irrespective of the actual nominal per bond stated in the prospectus), one might also hear "one million bonds" taken to mean one million nominal.

each bond carries rights of conversion. The relationship between the conversion price and the conversion ratio is given by the following formula:

Conversion price = nominal value / conversion ratio

The conversion ratio for the *Widgets Convertible EUR 4% 2007* is calculated as follows:

Conversion price = nominal value / conversion ratio

Conversion price = €1,000 / 10

Conversion price = €100

There is an equivalence between the concept of conversion price and the strike price of an option. In a single currency convertible with redemption at par, it will be rational to convert rather than allow the bonds to mature if the share price is over the conversion price. The convertibles market borrows some other terminology from the options market:

- If the share price is over the conversion price, the convertible is said to be *in-the-money;*
- If the share price is under the conversion price, the convertible is said to be *out-of-the-money.*

The share price of Widgets at the time of the convertible issue is €80. As the conversion price on the *Widgets Convertible EUR 4% 2007* (€100) is above the share price of the stock, the convertible is said to be *out-of-the-money*. If the stock price were to approach and rise above €100, the *Widgets Convertible EUR 4% 2007* would gradually become classified as more at-the-money and then in-the-money.

Parity

Parity is the market value of the shares into which a convertible bond may be converted. Parity is expressed in terms of the bond currency and is normally quoted as a percentage of par, except in the case of French bonds where it is generally quoted in 'per unit' form.

*Parity = conversion ratio * current share price*[2]

For the *Widgets Convertible EUR 4% 2007*, parity is calculated as follows:

*Parity = 10 * €80*

Parity = 800 (per bond of €1,000)

Parity = 80%

In a single currency convertible, parity moves with the underlying share price. In a cross-currency bond (where the bond currency differs from that of the underlying equity) movements in the exchange rate between the stock and bond will also influence parity.

Premium

The percentage premium is the difference between the bond's price and its equity value or parity, expressed in percentage terms.

Premium = Convertible Price/ Parity –1 [*or (Convertible Price – Parity)/Parity*]

The premium on the *Widgets Convertible EUR 4% 2007* is:

Premium = 1000 /800 -1

Premium = 25%

[2] Expressed in the currency of the convertible

Premium can also be calculated in per share form. Thus:

Premium = Price of one share bought via the convertible/ Share price -1

Where:

Price of one share bought via the convertible = convertible price/conversion ratio

In this case:

Price of one share bought via the convertible = 1000/10

Price of one share bought via the convertible = 100

And:

Premium= 100/80-1

Premium = 25%

'Absolute premium' is the difference between the bond's price and parity. It is used in some calculations such as 'breakeven' (see below)

Current or 'running' yield

The current yield on a convertible is similar to the dividend yield on a stock; both are defined below.

Dividend yield = dividend per share / current share price

Running yield = coupon / current convertible price

At issue, the running yield on the *Widgets Convertible EUR 4% 2007* was:

Running yield = coupon / current convertible price

Running yield = €40 / €1,000

Running yield = 4%

A convertible's current or running yield will change over the life of a bond as the convertible price varies.

For a convertible that by convention is quoted with accrued interest included in the price, such as a French bond, analysts will sometimes use a notional clean price to calculate a current yield that is comparable with those of bonds that are quoted 'clean'.

Yield advantage

Convertible yield advantage = convertible running yield – equity dividend yield

For the *Widgets EUR 4% 2007*:

Convertible yield advantage at issue = 4.0% - 2.5%

Convertible yield advantage at issue = 1.5%

Breakeven

'*Breakeven*' on a convertible may be thought of as the length of time (in years) that it takes for a convertible's extra income to compensate for its premium. '*Breakeven*' is a crude measure that makes no adjustment for the present value of future cash flows.

*Breakeven = absolute premium / [coupon – (dividend per share * conversion ratio)]*

For the *Widgets Convertible EUR 4% 2007*:

*Breakeven = absolute premium / [coupon – (dividend per share * conversion ratio)]*

*Breakeven = €200 / [€40 – (€2 * 10)]*

Breakeven = 200 / 20

Breakeven = 10 years

Since the *Widgets 4% 2007* only has a five-year maturity, and a breakeven of ten years, it is clear that its price cannot be justified on income grounds alone.

Yield to maturity (YTM)

A bond's yield to maturity (YTM) is the rate of return that an investor will receive if the bond is held to maturity[3]. As with other fixed interest instruments, the convertible's YTM is inversely correlated to its price.

Bond floor or investment value

A convertible's bond floor, or investment value, is calculated by considering the fixed income attributes of a convertible security in isolation. The investment value of a convertible is found by discounting to present value its coupons and redemption value. This is the same calculation that would be applied to a normal fixed income security to determine its value.

The discount rate generally applied to a bond's cash flows is the sum of the risk-free rate relevant for the maturity of the bond and a credit spread, which reflects the credit quality of the issuer[4]. Without its conversion option, a convertible would be worth no more than its investment value.

Using the risk-free rate plus credit spread method described above, the investment value on the *Widgets Convertible EUR 4% 2007* bond at issue was 89.91% of its par value. Please refer to the *Appendix* for a more detailed calculation.

The Libor, or swap curve (for the relevant underlying currency) is conventionally used in the Euroconvertible market as a proxy for the risk-free rate[5]. When choosing a credit spread, one is forced to make an assumption on the credit quality of the issuer, for example by referring to credit derivative or corporate bond markets.

In theory, independent of the performance of the underlying share price, the convertible should be worth at least its bond floor. However a dramatic fall in the share price of a company can damage the issuer's perceived credit quality, which will tend to lower the bond floor.

Risk premium

A convertible's risk premium is the excess of the market price of the convertible over its bond floor. It is normally expressed as a percentage.

Risk premium = convertible price / bond floor -1

The risk premium on the *Widgets Convertible EUR 4% 2007* at issue was:

Risk premium = 100 / 89.91 - 1

Risk premium = 11.22%

[3] This is a simplified definition which ignores the reinvestment of coupon interest. For a more complete treatment of *YTM*, please see the Appendix.
[4] An alternative method for calculating the bond floor considers the spot yield curve and discounts each future payment using the appropriate spot rate plus credit spread.
[5] Ideally sovereign debt of the nation associated with the currency in question should be used. For example the Treasury yield curve should be used for US dollar bonds. Though swap rates are higher than Treasury rates, there is a compensatory effect in that the spread over swaps for a given corporate bond will be tighter than the spread over Treasuries.

The difference between a convertible's price and its bond floor can be seen as the value that the market places on the option to convert. The risk premium measures how much of a 'premium' to the bond floor a fixed-income investor is required to pay for an option on the underlying shares.

Call protection

Many convertibles have call features. A call feature gives the issuer the right to redeem a convertible before maturity (from the call date) at a predetermined price (the call price). The call price of a bond is often par. In OID or premium redemption securities it is typically at the accreted price.

The *Widgets 4% 2007* can be called at par, or 100% of its nominal value. However, it cannot be called for at least three years (the bond has three years of '*hard call*' protection). The *Widgets 4% 2007* cannot be called at all until after this initial three-year period has expired. Thereafter there is a '*soft call*' (sometimes referred to as its provisional call) period, during which the convertible can only be called if the share price has reached some specified level. Our notional bond has two-year '*soft call*' period. The issuer can only call the bond if the stock trades at 130% of the initial conversion price, or €130, for at least 20 days[6].

When a bond is called, investors almost invariably[7] have the right to choose whether to accept the call price plus accrued interest[8], or to convert into the underlying shares. In making this investment decision, investors should compare the value of the call price plus accrued interest with the current market value of the shares they would receive on conversion — this is parity. (Note that on conversion, investors normally forfeit any accrued interest).

If parity is greater than the call price plus accrued interest, the issuer's decision to call the bond back will, in effect, force investors to convert into shares.

The intention behind the issuance of a call notice is frequently to force conversion. For this reason the issuer may delay calling the bond until parity is well above the call plus accrued interest price, to reduce the chance that share price weakness during the required notice period of the call (typically between 30 and 90 days), will deter bond-holders from converting.

Sometimes it may be rational for an issuer to call a bond even if parity is well below the call price. This may be the case either if interest rates have fallen or if the company's credit has improved placing the company in a position to refinance on more attractive terms. Calls for cash redemption are less common than calls forcing conversion.

Put features

While many convertibles have call features, investor put options are less common in Europe. A put feature gives the holder of the convertible the right to require the issuer to redeem a convertible on a predetermined date prior to maturity, at a fixed price. The issuer is usually required to redeem the convertible for cash. However, some convertibles give the issuer the option of delivering shares, or a mix of cash and shares. When settlement is in shares the term 'soft 'put' is sometimes applied.

[6] Note that the actual call price is of little importance in soft call bonds if it is well under the trigger level. Since the bond is worth 130 (say) converted, by definition, it does not really matter if the call price is 100 or 105 for example, as rational investors will convert.
[7] There are rare instances of a bond being callable before it can be converted.
[8] Assuming the call notice specifies payment of accrued interest. In instances where the call date falls on a coupon payment date, this issue does not arise.

Convertibles as derivatives

Equity investor viewpoint

Equity investors tend to view a convertible as a combination of:

- **Equity —** a convertible holder has control over a fixed number of shares. In terms of value, an investor 'owns' parity.
- **A put option** — a convertible holder has control over the underlying shares, but if the stock price falls, the investor can choose not to convert and instead to receive a cash redemption amount at maturity. The right not to convert is equivalent to a put option; imagine the investor automatically being delivered the fixed number of shares at maturity and then having the (notional) right to sell the package of shares back at the cash redemption amount. The rational investor will exercise this right if the redemption value is greater than parity
- **A dividend swap —** a convertible holder indirectly owns a certain number of shares, but receives coupons instead of dividends until the earlier of maturity or conversion. This is equivalent to owning a dividend swap that gives the equity investor fixed payments (the coupons) in exchange for dividends. Assuming there is an income advantage for the convertible holder, the investor will pay a premium to own this embedded dividend swap.

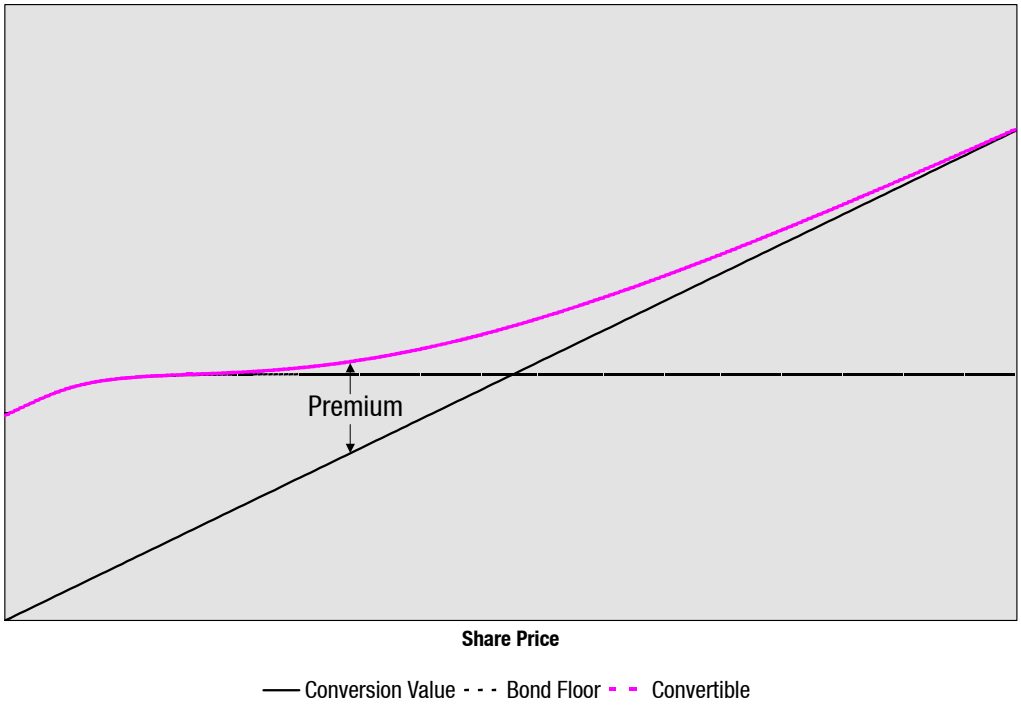
Bond investor viewpoint

Fixed income investors tend to view convertibles as a combination of:

- **A straight bond**: a convertible holder owns a straight corporate bond that pays coupons and has a cash redemption value at maturity. A convertible's bond floor represents this straight bond value.
- **A call option:** a convertible holder has the right to exchange his corporate bond for a predetermined number of the company's ordinary shares, usually at any time. This is equivalent to owning a call option that gives the fixed-income investor the right to acquire shares by giving up the convertible. At maturity this is equivalent to a call with a strike price equal to the conversion price (for a single currency par redemption bond). Unlike a conventional option, there is no cash payment on exercise.

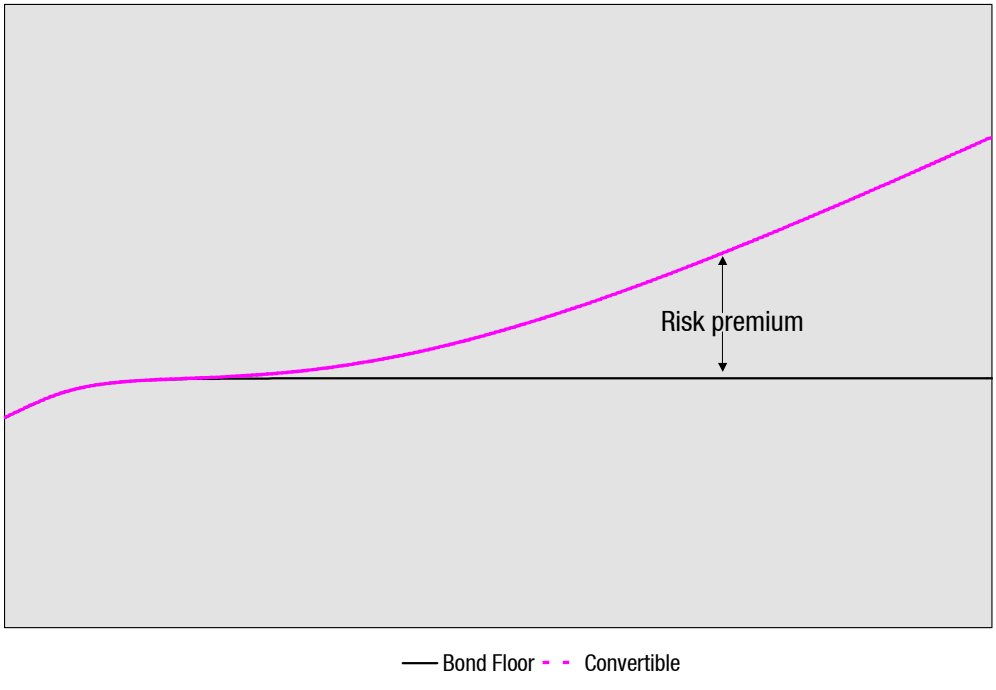
Figure 4 displays how the value of a convertible might vary with the share price some time before maturity.

Figure 4. Premium Against Share Price



Source: Citigroup.

Figure 5. Risk Premium Against Share Price



Source: Citigroup.

We note that:

- The bond floor of a convertible is not correlated with movements in the share price, unless a fall in the stock price is perceived to affect the credit quality of the issuer (shown in the extreme left of Figures 4 and 5 above).
- Parity (marked 'conversion value') varies proportionally with the share price, being the product of the share price and the conversion ratio. The slope of the parity line represents the conversion ratio.
- Figure 4 shows how investors purchasing shares via a convertible forfeit a degree of equity appreciation, the convertible price having less than 100% share sensitivity through most of the spectrum.
- The difference between the convertible price and the bond floor (the risk premium) represents the price of the embedded call option to a fixed income investor.
- The difference between the convertible price and parity (premium) represents the price of the embedded put option (downside protection) and the dividend swap (yield advantage) to an equity investor.
- Figure 4 illustrates how, as the equity price rises, the premium narrows to a point where the convertible derives its value from the equity component only (plus or minus any adjustment for income). When the share price rises, the value of the put option decreases; it becomes less likely that investors will exercise the option to 'sell' shares for cash redemption at maturity.
- When the equity price declines, the premium expands. The more the share price falls, the more the convertible price is supported by and trades in line with its bond floor.

Convertible price sensitivities — the Greeks

A convertible's theoretical value is positively correlated with**:**

- *The underlying stock price* — the higher the underlying stock price, the greater the value of parity (the equity component of a convertible), so the greater the value of the convertible.
- *Volatility of the underlying stock* — the higher the volatility of the underlying share, the greater the value of the convertible's embedded option (put or call, according to the equity or the fixed-income investor's perspective), so the greater the value of the convertible.
- *Issuer credit quality* —the better the credit quality of the issuer, the lower the discount factor applied to a bond's cash flows, the higher its bond floor and the greater its value.
- *Call protection* — the longer the call protection on a bond, the longer the period of any yield advantage in a convertible. Longer options also tend to be more valuable than shorter ones.

A convertible's value is negatively correlated with:

- *Stock dividends* — the higher the dividend, the lower the yield advantage of the convertible over the share.
- *Interest rates* — the higher the prevailing interest rate, the higher the discount rate for coupon payments and redemption value, the lower the bond floor and convertible's value. It is also true that the higher the interest rate, the greater the value of the convertible's embedded call and so the greater the convertible's value. Thus a convertible's price is less sensitive to interest rates movements than an otherwise identical straight-bond.
- We can describe the impact of various factors on the price of a convertible using the following concepts, which are more commonly referred to as the 'Greeks'; the 'Greeks' are outputs of convertible pricing models.

Delta

Delta describes the sensitivity of a convertible's price to changes in parity. It is a measure the equity sensitivity of the convertible. Conventionally, delta is expressed as the change in convertible price for a unit change in parity. Thus, a 40% delta means that if parity rises by one point, the convertible price will rise by 0.4 points (40% of the one-point change in parity)[9].

Gamma

Gamma is the rate of change in delta for movements in the underlying share price. It is often expressed as the change in delta for a one-point change in parity. There is no consistency of quotation convention for gamma however. Some measure the sensitivity of the delta to a 1% change in the share price, for example.

For significant share price moves, delta can be a poor guide to the sensitivity of the convertible. In general the convertible is more equity sensitive in rising markets and less sensitive in falling markets. Gamma is the measure of the intensity of this effect. This topic will be covered later when discussing '*gamma trading*'. A theoretical treatment of gamma and a chart of its sensitivity to the share price level are available in the Appendix.

Vega

Vega is the sensitivity of the convertible value to changes in the volatility of the underlying stock. Conventionally, vega is expressed as the change in the fair value of the convertible for a one percentage point increase in the assumption for stock volatility.

In order to find a theoretical value for a convertible (its theoretical '*fair value*'), it is necessary to input assumptions to a convertible pricing model:

- A credit spread (spread over Libor or Treasuries), used to establish the rate for discounting the bond's coupon payments and its redemption value;
- Dividends on the underlying share, to maturity; and
- A volatility assumption for the underlying stock.

Vega measures the sensitivity of fair value to changes in the assumed level of stock volatility. There are no short names in common use for the dividend and spread sensitivity[10].

In approximate terms the closer the convertible is to being at-the-money, the more sensitive its value is to changes in assumed volatility. A chart of vega against parity is available in the Appendix.

Rho

Rho[11] measures the sensitivity of convertible value to movements in interest rates. Conventionally, it is expressed as the change in convertible price for a one basis point move in interest rates (a parallel shift in the whole yield curve).

Rho is the fixed income sensitivity of the convertible just as delta was defined as the equity sensitivity.

Delta increases as parity (the equity component of the convertible) increases. Conversely, rho increases when parity decreases and the convertible derives an increasing proportion of its value from its fixed interest attributes.

A more thorough treatment of Rho is to be found in the Appendix.

Theta

Theta is the change in convertible price with the passage of time. It is not identical to the term as used in the options market as it combines the redemption pull of a bond with the time decay of an option. Conventionally, it is expressed

[9] To be precise it is the sensitivity to a very small move in parity rather than a one point move (see appendix).
[10] CR01 is a term used by some
[11] Also known as DV01

as the percentage change in convertible price for the passage of one day, all other things being equal. For a near-the-money convertible, the passage of time is normally negative for its value, the time decay of the option element outweighing any upward drift in the bond floor.

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Convertible Bonds: Investor Perspective

- ➤ **Convertibles for equity investors**
- ➤ **Convertibles for fixed income investors**
- ➤ **Preferred habitats**

Convertibles for equity investors

The way in which equity investors often look at convertibles is a reflection of the derivative breakdown of the asset class described in section 'convertibles as derivatives'. They are inclined to perceive the purchase of a convertible as equivalent to the purchase of a certain number of shares, the purchase of downside protection and (sometimes) the purchase of incremental income.

Equity investors will be attracted by the asymmetrical equity sensitivity of convertibles. As Figure 4 shows, there is a tendency for the convertible to become more equity sensitive in a rising share price environment and less so when the share price is falling. This gives the asset class interesting risk characteristics, which are not always captured by conventional measures. Measures such as standard deviation, which identify the incidence of extreme observations in either direction with risk, implicitly assume that the overall return profile is symmetrical. To take an extreme example of the power of asymmetry, consider a notional instrument that can go up but not down. The standard deviation of expected returns may be high, but the instrument is not really 'risky', as the term is generally understood.

Switching shares into convertible — selecting the ratio

When an equity investor wishes to sell shares and replace them with convertible bonds, there are three common methods available for selecting the appropriate quantities to deal in:

- Retaining control of same number of shares;
- Cash-for-cash; and
- Applying a delta.

Retaining control of the same number of shares

This is a particularly interesting strategy for those who are uncomfortable with the loss of equity content that is typically involved in switching from shares to convertible. In effect it amounts to applying additional funds to the extent of the premium. In cases where the convertible looks cheap on income grounds alone there is particularly good justification for this approach. The move can be likened to buying back as many shares as are being sold and simultaneously investing in an annuity.

Cash-for-cash

The cash-for-cash switch is the most common strategy for equity investors. Paying a premium for the convertible involves the sacrifice of some involvement in the share in exchange for the defensive characteristics of the convertible.

Static delta

By mimicking the behaviour of the hedge fund and attempting to maintain equity sensitivity, the equity investor is doing more than merely retaining control of the same number of shares, he will typically have to put considerable additional funds to work. Unlike the hedge fund, the equity investor will not normally adjust the ratio over time. This means he can estimate at the time of the switch the circumstances under which the trade will prove to be profitable.

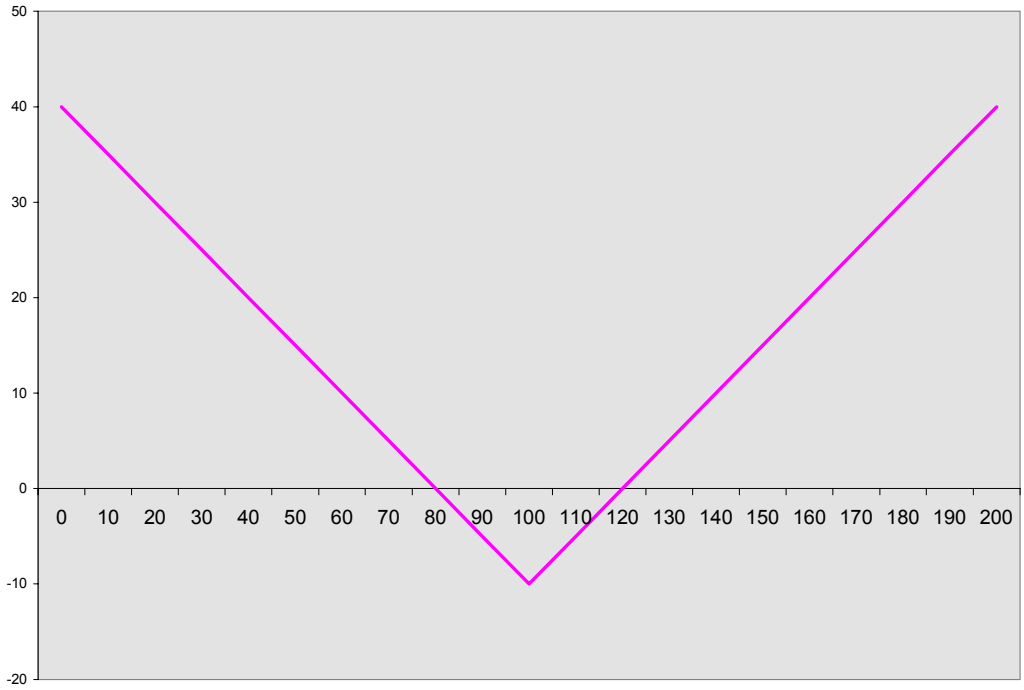
Take a convertible bought at 100 on which parity is 80 and the delta 50%. For every €100 invested in the convertible the sale of the underlying shares will only raise €40, so the balance of €60 must be borrowed or taken out of cash balances.

On the upside, if parity at maturity is *x* the 'long convertible, short cash' position will be worth *x*-60 and the 'short shares' position will be worth -.5*x*. Ignoring income and financing considerations the trade will have proved profitable if parity ends above 120. For example, if parity ends at 200 the investors 'long convertible short cash' position will be worth 140, and the value of the 'short shares' position 100, making the switch profit 40.

On the downside the least the 'long convertible, short cash' position will be worth is 40 (default excepted). Ignoring income and financing considerations the trade will have proved profitable if parity ends below 80.

The 'strangle-like' payoff of the whole position (long convertible, short cash, short shares on a delta) is shown in Figure 6.

Figure 6. Payoff Profile of Convertible Hedged on a Static Delta



Source: Citigroup.

These 'static hedge' calculations, on which Smith Barney in New York has carried out extensive analysis, provide additional insights into the relationship between share price prospects and the value of a convertible bond.

Preferred habitat — in-the-money convertibles

Convertibles which trade on very low premiums are often candidates for equity investors, as they are a better proxy for the shares themselves. Such convertibles typically have high deltas and a relatively distant investment value (i.e. a high risk premium).

Some equity investors are attracted by the income characteristics of certain convertibles. This is particularly so if the premium paid is made up for by an income advantage over the underlying shares. Instances in which the premium is amortised before the first call date of the convertible have evident appeal (see the definition of '*breakeven*').

Convertibles for fixed income investors

For a fixed income investor, the purchase of a convertible is equivalent to the purchase of a straight bond together with the purchase of upside participation in any underlying share price appreciation. The straight-bond component is the bond floor and upside participation comes from the embedded call option to purchase the underlying shares. The risk premium in this context represents the premium to the bond floor a fixed-income investor pays in order to gain access to participation in upward moves in the underlying shares.

When the underlying share price rises, the risk premium on the convertible will tend to expand, as the call option becomes more valuable.

When the underlying share price (and convertible price) falls, the risk premium contracts, as the call becomes more out-of-the-money. The convertible price will fall, but as long as the fall in the underlying share price does not affect the credit quality of the issuer, the convertible's bond floor (its fixed interest value) should support its price.

Risk premium expansion can be interpreted as the potential advantage that a fixed income investor stands to gain by switching from a straight bond into a convertible, if the underlying share price rises. Conversely, the risk premium describes the amount that a fixed income investor stands to lose from switching a straight bond into a convertible, if the underlying share price falls.

The position of convertibles as a 'halfway house' between fixed income and straight equity is especially relevant for the many institutional investors who are bound by a requirement to invest only in bonds, or to keep a large proportion of their portfolio in fixed-income securities. As convertibles are often classified as bonds, fixed-income investors may use them to inject equity elements into their portfolios.

Expected yield to maturity

Conventionally the yield to redemption of a convertible is calculated using the formal redemption price of the instrument. However a concept of 'expected yield to maturity' is a useful one when looking at convertibles from the standpoint of the fixed interest investor. In this case one ascribes probabilities to different share price outcomes and thus different effective bond redemption prices. One arrives at an 'expected redemption price' and calculates an expected yield to maturity accordingly. There are parallels between this approach and a classic options approach except that in this case one does not solve for fair value, one solves for the discount rate that renders the convertible fair value at the current price.

Preferred habitat — out-of-the-money convertibles

Traditionally, fixed-income investors with a low risk profile have preferred to buy out-of-the-money convertibles since they trade close to their bond floor and can offer low cost call options on the price performance of the underlying shares. Despite offering only a small element of equity sensitivity, an out-of-the-money call still give an investor the chance to participate in any appreciation of the underlying stock (even if only moderately, on account of the low delta that typifies an out-of-the-money convertible security). On the other hand, they will have paid little for this option, limiting the potential loss on share price falls. Since rho is high on an out-of-the-money convertible, it will respond to movements in interest rates and credit spreads in a similar fashion to a straight bond. As the underlying share price rises, fixed income investors may be tempted to lock in their profit and sell the convertible, due to the expansion of the risk premium.

In some cases, fixed income investors may not be motivated at all by upside participation in underlying share appreciation and may only be interested in the bond component of the convertible. In this case they will buy deep out-of-the-money convertibles, as they will be reluctant to pay any premium to the perceived bond floor. This type of investor may find a yield advantage in convertibles compared to their related straight-bonds due to anomalies in the secondary market in which convertibles are traded. Moreover, the relative coupon structure and sometimes the subordination of the convertible can differentiate it from other debt of the issuer. Often the convertible will present a higher risk/higher reward profile than other corporate debt, making it attractive to certain investors.

Convertible Bonds: Hedge Fund Perspective

As discussed in the previous section, the value of a convertible bond is sensitive to the behaviour of a number of variables:

- Share price.
- FX (for cross currency bonds).
- Yield curve movements.
- Option valuations.
- Dividends.
- Credit spreads.
- Stock borrow costs.

One way of describing the difference in the attitude of the traditional unhedged investor and the hedge fund is that the former makes investment decisions based on his view on the combined impact of all these variables, whereas the hedge fund will choose to take a view on a fewer number of variables by neutralising his sensitivity to the others. At the extreme, in a 'pure arbitrage' situation, the hedge fund will seek to offset all influences on a cheap convertible to lock in a risk-free profit.

Another differentiating characteristic of hedge funds is their characteristic high gearing. Though hedge funds are not the only institutions with an element of portfolio gearing, they typically have a much higher ratio of long positions to funds under management. This is achieved by borrowing and by 'netting off' short positions against long positions.

Hedging equity risk

It is possible to construct a portfolio that is theoretically insulated from small share price movements. This portfolio is based on a long convertible position and a short position in the underlying share. The number of shares that must be sold is indicated by the convertible's delta or '*hedge ratio*'.

Delta hedging and gamma trading

If the delta — the change in the convertible price for a one-point change in parity — of a convertible were 40%, it would be necessary to sell a number of shares equal to 40% of the number into which the bond may be converted, to hedge it successfully against small share price movements.

When the move in the underlying shares is not small, the effect of convexity (gamma) on the convertible price becomes material. For significant movements in the underlying share, the hedged portfolio will generate a positive return regardless of the direction of the underlying price move, other things[12] being equal.

As the share price underlying a convertible rises, the delta will also rise. This causes the hedge ratio to increase, meaning that more shares need to be sold to keep the portfolio delta neutral. As the underlying share price falls, the convertible's delta falls and some shares must be bought back in order to re-hedge the position. Thus hedged investors tend to buy shares after a price fall and sell after a price rise, This process of rebalancing, termed 'gamma trading' is one way in which hedge investors seek to generate profits from their portfolios.

[12] Including time. The gamma analysis looks at a snapshot in time, it ignores the fact that prices changes which take place over a period of time will be accompanied by the effects of time decay.

Figure 7 below uses the details of the notional *Widgets EUR 4% 2007* issue, used above.

Figure 7. Widgets Convertible 4% 2007 Long Convertible Position

Convertible Price	Eur1000
Conversion Ratio	10
Underlying Share Price	Eur80
Delta	40%
Gamma	0.5%

Source: Citigroup Convertibles.

In order to hedge the long position of one bond against changes in the underlying share price, we need to take a short position in 40 shares:

Short share sale = conversion ratio * delta

Short share sale = 100 * 40%

Short share sale = 40 shares

When the underlying share price rises, the convertible's delta also rises. As a result, the profit on the long convertible position should be greater than the loss suffered on the short position in the underlying stock. The net position from the trade is a profit.

Conversely, as the underlying share price falls (causing the delta of the convertible to fall), the bond will participate in a diminishing proportion of the decline, due to the effect of gamma. The loss on the convertible long position should be smaller than the profit on the short sale of the underlying stock. Again, the net position from the trade is a profit.

The size of any profit on this type of trade is dependent on both the extent of the move in the underlying stock and on the bond's gamma profile. Note:

- The greater the move in the underlying share price, the greater the chance of significant gamma trading profits.
- Stock volatility is a measure of the propensity of the underlying share to move sharply. The higher the underlying stock volatility, the greater the potential profits from the hedged convertible position.
- Delta hedging is most effective when a convertible is theoretically cheap — an investor will expect to capture more volatility than he has 'paid for'. Theoretical fair value depends on several variables including the assumed volatility of the underlying shares. An investor will estimate the level of underlying stock volatility and input this in to a convertible pricing model. Convertibles trade at prices that can be higher or lower than theoretical fair value, due to supply and demand. 'Implied volatility' is the stock volatility that is theoretically implied by the convertible's market price.
- The choice of hedge ratio is by no means simple. If the hedged investor believes the convertible to be mis-priced, he must decide whether to hedge on the model output given his own volatility assumption or on model output using the implied volatility[13]. He may also look at the 'empirical volatility'; the historical relationship between parity and share price suggested by regression analysis.
- Hedge investors using this strategy to trade their convertible portfolios, are employing a technique known as 'trading the gamma'. Gamma trading is not infallible, however. Shares do not always exhibit sufficient volatility for the strategy to make money. The loss of value as a result of time decay (theta) can prove the more important factor.

[13] For an extreme example, consider a convertible on a zero implied volatility. Does the investor want to take the free option and not hedge it or hedge on the basis of what he thinks the option is worth? Probably the latter in our view, which argues in favour of hedging on the basis of ones own assumed volatility.

Hedging currency risk

The hedge fund's easiest way of dealing with currency risk in a cross currency bond is to put on the equity hedge by selling shares denominated in the currency of the bond. This leaves the investor with the currency risk of a single currency bond (ie none at all if he is measured in terms of the bond currency). Where no such ADR type instrument is available, it is sometimes possible to deal in one synthetically through a cross-currency equity swap.

For those (including the issuer) who wish to know what the FX exposure is in isolation, the problem is complex. At the extremes the situation is reasonably clear. A 100% delta convertible is pure equity; to hedge one sells all the shares into which one has conversion rights and carries out any spot foreign exchange transaction needed to receive the proceeds in the investor's base currency[14]. If the convertible is on a zero delta, the instrument is a pure fixed interest instrument. If the bond is denominated in a currency other than the investor's base currency he can in theory hedge the exposure by executing forward transactions on all future payments from the bond.

Between these extremes it is necessary to estimate probabilities for different foreign exchange requirements at different dates and hedge these accordingly. This is naturally not a static hedge. In order to generate the probabilities two possible approaches are an amended binomial tree approach and a Monte Carlo simulation approach[15].

Hedging yield curve exposure

Consider a vanilla non-callable convertible[16] in a flat yield curve environment. The pay-off can be replicated as a corporate bond and a call option. Each of these has its characteristic yield sensitivity, the bond benefiting from yield declines and the option component benefiting from yield increases[17]. The bond component will prevail leaving convertibles with yield exposure of the same direction as straight bonds, but of a lower magnitude.

Complications arise from the fact that yield curves are not flat and from the lack of certainty over which points in the yield curve are of relevance. In a coupon-paying bond there is some yield exposure at every coupon date until conversion or redemption as well as the exposure at that date itself. If the expected life of a convertible falls short of the final maturity date, the latter may not be an important yield curve point. Many practitioners obtain model output for yield exposure in given 'time buckets' for individual positions and aggregate across a portfolio.

Hedging convertible vega risk

Although in many cases a hedge fund will retain the option element of a convertible and hedge this dynamically against the share, on occasions it will wish to hedge its option value exposure. This may be the case, for instance, if it wishes to lock in the profit from a pricing anomaly between pure options and those embedded in a convertible.

It is normally impossible to replicate the exact option embedded in the convertible, due to call features. Sometimes approximations can be made using the fugit (or expected) life. Even here there are technical and practical difficulties. One theoretical problem is that the fugit life date can be very imprecise. For example, if the convertible has a 50% chance of lasting one year and a 50% chance of lasting five years the fugit life will be three years, but hedging with a three-year option would not be a very accurate hedge[18]. A further theoretical problem lies in the difficulty of identifying the appropriate strike price for the equivalent option. If the adopted horizon is the maturity date, the strike in per share terms will be the redemption price divided by the conversion ratio[19], but if it is some other date it will be the prevailing bond floor divided by the conversion ratio. The prevailing bond floor can only be estimated.

Even if the investor is satisfied as to the specification of the nearest option to that embedded in the convertible, there remains the practical problem that no options of that description may be available (to buy or sell). For example, one may conclude that a four-year 100% out-of-the-money call is the appropriate contract, but discover that strikes more that 50% away from the money or with more than two years to final expiration are not available in the name in

[14] There may remain some residual currency risk relating to the coupons; these would have to be dealt with using one of the techniques discussed.
[15] See *Analysing Currency Risk in Cross-Border Equity-Linked Bonds*, Bapi Maitra and Eu Jin Ang, of CitFX, RISK Magazine March 2002.
[16] Further assume there are no rights of early conversion so that it is a European option.
[17] Other things being equal the higher the interest rate the higher the forward price and the more a call option is worth.
[18] One way of checking the precision of the fugit number is to check it against 'reciprocal fugit' or the harmonic mean life. If the two measures agree the expected date will be exact.
[19] Possibly with an adjustment for accrued interest.

question. In this case one approach is to match the vega of the convertible and an option of a different specification perhaps a two-year 50% out-of-the-money contract. This would leave the investor with interest rate and equity exposure, which could be hedgeable through other means and an exposure to time decay which he may have to tolerate.

Hedging convertible dividend risk

The dividend exposure of a convertible is best seen by returning to the two derivative decompositions of a convertible. If the convertible is looked on as a bond plus an option, all the dividend risk lies in the option component. If the vega is hedged through the sale of a similarly specified pure option, the dividend risk will also be eliminated. The representation of the convertible as a share plus a put plus an income difference makes explicit reference to the dividend component allowing it to be hedged explicitly.

The natural mechanism to hedge this exposure is the dividend swap. An investor can contract to pay fixed amounts for a fixed period in exchange for variable dividend related amounts. The major practical difficulty is that an investor seldom knows for certain how many dividend payments he wishes to swap. He must either accept a possible mismatch or enter into a more complex cancellable contract.

Hedging credit risk — callable asset swaps

Description

A callable asset swap seeks to repackage the convertible such that one party owns only the fixed income component of the security and the other owns the option component.

In reality a callable asset swap is not a swap at all, as there is no exchange of future flows. It is a contract in which the option investor sells the convertible to the bond investor below the market price and retains the right to buy it back. The bond investor acquires an asset with most of the interest rate and credit characteristics of a normal bond. The option investor, through his call option on the convertible, mimics the circumstance of having a call on the underlying shares. The objective is for the option buyer to have no exposure to credit of the underlying share and no interest rate exposure except that of a stock warrant.

The terms of the contract specify the cash amount due for selling the convertible and the formula for calculating the price at which the convertible may be bought back. The cash amount corresponds to the value of the convertible's bond floor, calculated at a given credit spread over Libor. The price at which the convertible may be repurchased is worked out as another bond floor, calculated using a lower credit spread.

For example, a swap is quoted at 100/50. The '100' relates to L+100bp, the rate at which the trade takes place (at which the initial bond floor is calculated). The '50' relates to L+50bp, which is the recall spread. So if LIBOR is 5% and the bond purchased is a three-year, 0% bond redeemable at 100, the initial sale takes place at 84.0 (the present value of 100 in three years discounted at 6%). The recall price today is 85.16 (the present value of 100 discounted at 5.5%). If Libor increases to 6% in the next year, the recall price would go to 88.2 (the present value of 100 in two years, discounted at 6.5%). As the bond nears maturity, the recall price naturally nears the redemption price.

The credit spread at which a fixed income investor buys the bond element of a convertible in a callable asset swap may be higher than the credit spread implied in the price of a straight-bond with the same profile. Thus, a fixed-income investor may be able to buy a straight bond proxy at an advantageous yield.

To understand why it is a reasonable proxy in most circumstances, one must look at the situation of the bond investor at the maturity of the bond. The option investor has the option of buying the convertible at (about) the redemption price. Whether or not this right is exercised, the bond investor is assured of getting the redemption price at maturity (default excepted).

There are ways in which the callable asset swap fails in its objective of delivering a bond equivalent to one counterparty and an option equivalent to the other, however. Pronounced spread narrowing may mean that the bond investor may be put in a situation in which he is required to sell the bond below the fair market price of a pure bond with similar terms; there is in essence a credit option against him.

Callable asset swaps can also miss their objectives due to complications arising from early recall. This generally involves a penalty for the option investors and 'windfall' for the bond investor. To the extent that the option investor pays more than the bond floor when it comes to buying the convertible back, he is suffering a penalty. For the bond investor, the possibility of an early call is positive on balance. The chance of the bond being called above fair value as a pure bond is greater than being called below fair value, since the recall spread at the time the contract is made was tighter than the market price of the credit at the time.

Valuing existing callable asset swap contracts

The embedded credit options and early exercise features present interesting valuation problems for the callable asset swap. One mark-to-market technique for the option investor is the intrinsic value approach; the position is valued as if the bond were recalled immediately. At first glance the approach appears to have merits; it is easy to calculate and tends to value the position conservatively. However, it is sometimes so conservative as to be a patent

misrepresentation of the true value. For example, it calls for the position to be marked at zero if the bond floor at the recall spread is higher than the market price of the convertible, yet the right to buy the convertible in the future has palpable value (which could be realised on reassignment of the contract).

The other end of the conservatism spectrum is to assume that the convertible can be recalled without penalty, that is to say at the bond floor. In situations in which the option to recall early is unlikely to be exercised, this is a fair reflection of the value of the contract.

A compromise solution is to include a proportion of the recall penalty, having regard to the probable timing of any early exercise.

Hedging convertible credit risk — credit default swaps

Description

Credit default swaps (CDS) are now the most common medium for transferal of credit risk. Typically, one party in the swap faces credit risk from a certain entity, and the counterparty in the credit default swap agrees to assume this risk in exchange for regular periodic payments. If the reference entity defaults (or in the case of certain other credit events), the party providing insurance will typically have to purchase from the insured party one of the specified basket of assets at face value.

The regular stream of fees paid to the protection seller is typically expressed in basis points per annum ('default swap spread'). The default swap spread is indicative of the credit quality of the reference obligation; the higher the default swap premium, the more default-prone the reference obligation is deemed to be. The fee ends when the contract is terminated or reaches its final maturity, typically between three and ten years.

For example, suppose two parties enter into a five-year credit default swap. Assume that the notional principal is US$100 million and the buyer agrees to pay 90 basis points annually for protection. If the reference entity does not default, the buyer receives no payoff and pays US$900,000 per year (normally in quarterly installments) for each of the five years.

The convention for quoting CDS prices is as follows: the bid is the price that the market maker would pay to buy protection (sell the risk), and the offer is the fixed rate that he would require to provide protection (take the risk) in physically settled contracts[20].

Documentation

Before entering into a transaction, both parties in the default swap usually have a 'signed ISDA' in place. This sets forth the rights and duties of the two parties under all swap contracts. Early credit derivative contracts suffered from ambiguity surrounding the documentation of the agreements. Since 1999, ISDA has provided standard templates to document default swap transactions. These contracts are governed by a set of common rules and definitions published by ISDA. Before a credit default swap is executed, credit lines between the counterparties must be in place because each party is taking on credit exposure to the other.

On 20 June 2003, the new 2003 ISDA credit derivatives definitions came into use generally. These set out the framework of legal terms of the Credit Default Swap contracts and spell out the different choices available when writing a CDS contract. The new definitions are intended to replace the 1999 definitions. The six possible credit events that can occur within these new ISDA definitions are bankruptcy, failure to pay, restructuring, repudiation and obligation acceleration.

In 2001, modified restructuring was introduced to address the problems in restructuring as a credit event. In an attempt to harmonise standards worldwide, ISDA together with European CDS users developed a new option. This

[20] Note that unlike most yield-based quotations, the bid is lower than the offer.

option is included in the 2003 definitions and is referred to as modified modified restructuring (Mod-Mod-R). It sets out the framework of legal terms of CDS. Under Mod-Mod-R, qualifying for delivery following a restructuring credit event is limited to obligations with a maturity date not later than the restructuring date plus 60 months if delivering a restructured loan, the restructuring date plus 30 months for other deliverable obligations or the scheduled termination date of the CDS if it is later.

There are two main changes that have come about in the 2003 ISDA definitions with regards to the eligibility of bonds for delivery against CDS contracts following a default event. Firstly, CHF bonds are now deliverable as standard in addition to G7 currencies. Second, on restructuring, (generally) only bonds with a maturity of less than 30 months from the contract date are deliverable.

Several credit events definitions were also amended, including bankruptcy, repudiation and restructuring. The 2003 definitions offer parties four choices relating to restructuring. These are trade without restructuring, trade with full restructuring, trade with modified restructuring and trade with modified modified restructuring. There are also alternative procedures for when a bond or loan specified in the notice of physical settlement is not delivered, with the introduction of a binding notice of physical settlement.

Procedure on credit event

If a credit event occurs, a credit event notice is sent out. Generally, this notice is supported by a minimum of two publicly available sources such as *The Financial Times* or *Bloomberg*, depending on the CDS terms. This allows the buyer to exercise the right to put the deliverable obligation to the seller at par. The notice informs the seller (or buyer), which credit event has occurred within a specified interval of time called the 'notice delivery period'. The notice is an expression of the buyer's intent to settle the credit default swap contract and contains a detailed description of the type of deliverable obligations that the buyer reasonably expects to deliver to the seller. A deliverable obligation must typically be either a bond or a loan and must meet certain criteria. If the contract is physically settled, the seller pays par to the buyer in exchange for the deliverable obligation. In some special cases delivery cannot be completed. In such cases, a market value is determined for the reference obligation and a cash payment is made to the protection buyer for the implied loss on that obligation (the difference between par and the market value). If market conditions prohibit the successful delivery of the obligations to the seller, the transaction terminates unexercised. If no credit events occur during the term of the default swap the swap expires unexercised. Between 70% and 85% of CDS contracts are physically settled, with cash settlement being the second most popular. Fewer than 10% of contracts are completed via a 'fixed amount' approach. This calls for the protection seller to hand over a pre-negotiated amount to the buyer on default. The object is to reduce difficulties in assessing the recovery values.

When market conditions dictate, an investor may wish to terminate the swap prior to the final maturity of the default swap, for example, when the investor wants to book a profit. In such a situation, the investor will, in most situations, unwind the default swap contract with the dealer with whom he entered into the transaction at the current market level of the swap.

The CDS delta

There has been considerable debate about the appropriate size of a given CDS hedge. Some advocate a 'nominal for nominal' approach while others argue that the greater the equity exposure, the less the bond exposure and thus the lower the neutral hedge. Market consensus has now settled to using models to solve this problem. Since sensitivity to yield change can be read from both convertible and CDS models, the CDS delta is taken as the ratio of the two.

Hedging convertible credit risk — buying put options

The idea behind buying out-of-the-money put options to hedge credit exposure is that a company getting into credit difficulties is likely to experience share price weakness. The increasing value of the put options should compensate

for the decreasing value of the bond position. Ultimately if default is associated with a zero share price the payoff from the puts can act as a substitute for the redemption value of the bonds.

For example, an investor owns US$1 million nominal of a one-year bond. The share price of the issuer stands at 100. One-year puts with a strike price of 25 can be bought for US$1. The investor buys 40,000 such puts. If the company defaults and the share price goes to zero, the payoff on the put options will be US$25*40,000 or US$1,000,000, replacing the redemption proceeds on the bond even if the recovery rate is zero. For US$40,000 the investor has 'insured' his bond position.

Notional put purchase — adjusting the delta

A development of the idea of buying out-of-the-money puts in the market is to calculate the selling activity in the share the counterparty to such a transaction would undertake. Instead of buying the puts the investor simply sells shares on the calculated delta. In a sense he has sold the put option to himself and hedged accordingly. There is an interesting coming together of older and newer hedging approaches in this process. Increasing the delta on a convertible position is a conventional expedient for dealing with situations in which a weak share price is likely to be associated with a widening credit spread.

A note on capital structure arbitrage

When assessing the relative attractions of buying credit protection in the credit derivatives market and buying put options, hedge investors sometimes found marked discrepancies. Not surprisingly, a new activity grew up in which protection was simultaneously bought through one medium and sold through another. These types of trades have become known as 'capital structure arbitrage'.

In the early days of capital structure arbitrage, the major focus was on the arbitrage limits of certain combinations. For example if it is assumed that default inevitably means a share price going to zero one can easily calculate how many put options would be required to replace the maturity amount of the bonds (see above). Even ignoring any other value coming from ownership of the puts the cost may be much less than the cost of buying credit protection in the credit derivatives market.

The market is now awake to these pure arbitrage conditions and the business of capital structure arbitrage tend to focus on whether the implied probability of default in options and CDS prices are markedly different.

The most contentious matter in computing the implied probability of default from CDS levels regards recovery levels. If zero recovery is assumed, the CDS level itself is an approximate measure of the implied probability of default as the following example illustrates. Take a situation in which one-year risk free yields are 5% and the probability of default for a certain credit is 4%, making the expected payoff a 96% chance of getting 100 and a 4% chance of getting 0. The fair value of the risk free bond is 95.24 (100/1.05), the probability weighted fair value of the risky bond is 91.43 (100*.96/1.05 +0*.04/1.05). So the present value of credit protection is 3.81 or 381 basis points.

The most common technique for estimating implied default probabilities from option prices works through a line of reasoning that has become known as Merton analysis. The value of the whole firm is seen as the underlying variable and default is identified with the value of the firm falling below the value of the debt. Using volatility estimates for the enterprise derived from those of the share, and debt level figures taken from the balance sheet, a probability of default for a given time horizon is estimated.

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Convertible Bonds: Issuer Perspective

- **Convertible financing**
- **Financing objectives and prospective issuers**
- **To call or not to call?**

Convertible financing

There are mirror images in the view of convertibles from the issuer's point of view and from that of the investor. As has been discussed, investors would do better investing directly in shares, when the underlying share price rises and would do better owning straight debt, when the underlying share price falls than they would owing a convertible. From a post hoc issuer's standpoint, equity issuance would typically have been superior to convertible issuance if the share price has fallen and bond issuance would have been superior to convertible issuance if the share has been strong.

Limitations

The two types limitations to this idealised way of looking at the relative merits of bond, equity or convertible are the same for the issuer and the investor: practical considerations and uncertainty.

In the case of the investor one practical matter is likely to be portfolio constraints that limit the proportion of equity or fixed interest paper he may hold. In the case of the issuer, balance sheet structure is likely to be a constraint. Even if the company holds an optimistic view of its own share price, for example, there is a limit to the extent of balance sheet gearing that will be deemed appropriate. The way in which equity linked securities can be employed to solve the practical problems of issuers are discussed below (see *Financing objectives and prospective issuers*).

Uncertainty was the consideration that permitted the investor to consider equity/bond hybrids superior in terms of the overall risk and return profile to either asset class in isolation[21]. Likewise the issuer who issues a convertible avoids the 'worst-case scenario' of selling debt or equity at a time that posterity will show to have been unfortunate.

Financing objectives and prospective issuers

Alternative to equity funding

The idealised concept of choosing whether to issue equity or debt based on the perceived outlook for the share price is seldom realistic. However, if the choice is limited to convertible or pure equity, share price expectations may well be an important consideration. If the decision takers in an issuing company are confident of share price strength, the issue of a convertible looks very much like the issue of shares at a premium to market levels at the time of issue. The convertible issue carries none of the stigma sometimes associated with a rights issue and is often less cumbersome to execute.

Monetising equity investments

'Exchangeable' structures[22] can permit issuers to monetise stakes they hold in other companies in a convenient way. The issuer retains voting privileges, and can engineer prospectus terms to give delivery flexibility in the event of conversion or redemption.

[21] In the same way that uncertainty governs the theory of portfolio diversification.
[22] For more information on '*Exchangeables*', see page 37. They are convertible bonds issued by one company that can be converted into the shares of a different company.

Securing low-cost funding

One attraction of convertibles relative to straight bonds from the issuer's perspective is the lower coupon that will be commanded. Companies anxious to limit debt servicing costs may consider the grant of equity optionality an acceptable price to pay.

Tax/cash-flow advantages

Under most tax jurisdictions, only interest payments on debt are tax-deductible; dividends are paid out of after-tax income. Thus convertible debt financing is generally more tax efficient than equity issuance. In the case of zero coupon convertibles, no cash interest is actually paid, but in most tax regimes the company can deduct the interest implied by the accretion rate of the bond, creating a cash-flow advantage. In the case of exchangeable bonds, issuers are allowed to defer the crystallisation of tax liabilities on the sale of shares under many tax regimes, as beneficial ownership of the underlying shares transfers to the investors only on conversion.

Delaying dilution

Compared with the immediate issuance of equity, the issuance of a convertible may be beneficial for earnings per share. This is particularly true in cases where the probability of conversion is low, as analysts will typically employ undiluted EPS calculations. Moreover convertible investors do not have voting rights, so the issuance of a convertible defers the dilution of voting rights in the company. Closely held companies, for whom the issuance of voting shares may compromise control, may have a particular interest in raising equity capital via convertibles.

Exploiting market conditions

One advantage of issuing a convertible is that it can be completed as an 'overnight' transaction, whereas an equity issue typically takes several weeks. Speed of execution is a key advantage of convertible bond issuance.

Targeting a diverse investor base

The geographical and investment-style diversity of the convertible investor base enable the issuer to access a wide investment audience and enhance corporate recognition.

A company that has recently completed an equity issue may find it easier to raise further capital via a convertible rather than returning to the equity market. The size of a convertible issue that the market is capable of absorbing is often impressive.

Call decision framework

Often the ultimate goal of a convertible issuer is for its convertible bond to be converted into shares. Call features allow the issuer to precipitate conversion through the dispatch of a call notice. The company in this predicament has a dilemma when deciding whether or not to issue a call notice, however. If parity falls under the redemption value between the date investors are notified of the call and the call date itself, conversion is unlikely to be forced and the company would be required to redeem the security in cash.

For this reason many issuers will require a significant 'cushion' for the excess of parity over call price, before issuing a call notice.

Throughout the call period, that is the period between the issue of the call notice and last date on which investors must make the conversion election, the investor owns an option against the issuer. This is most easily thought of as being a put option: the investor 'owns' a parity number of shares but has the right to sell them back at the call price.

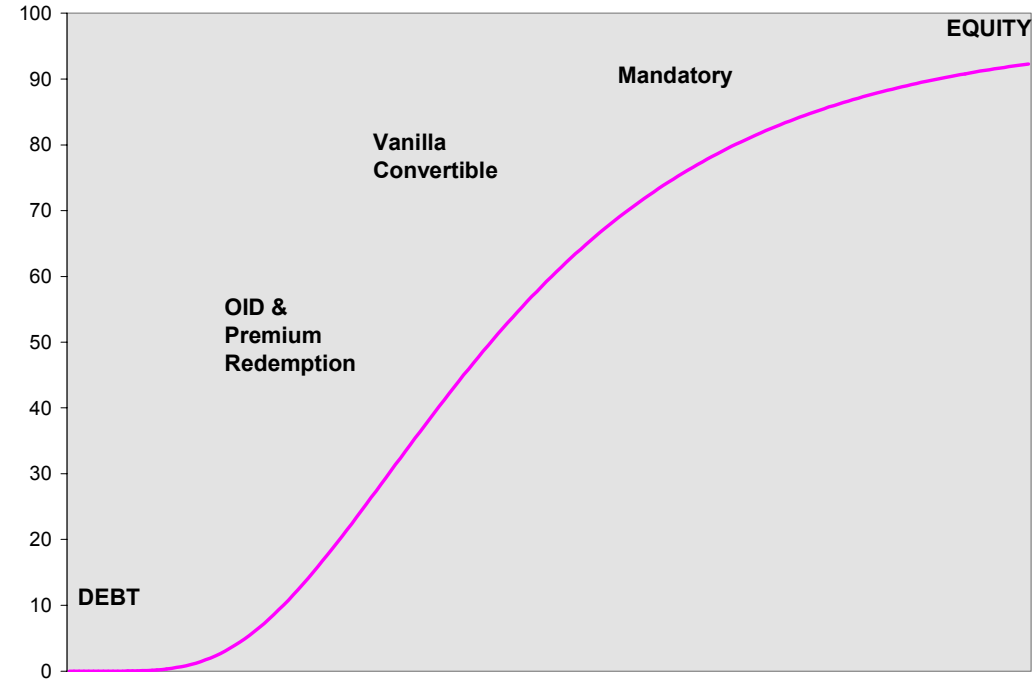
Convertible Structures

- The debt/equity spectrum
- Original issue discount (OID) convertibles
- Vanilla convertibles compared with a bond + warrant
- Convertible prefs
- Mandatory convertibles
- DECs
- PERCs
- Exchangeables
- Reset features
- FRNs

The debt/equity spectrum

Convertible securities can be structured such that they bear a greater resemblance to debt or equity investments. Figure 9 shows approximately where on the debt/equity spectrum the more common structures lie.

Figure 8. The Convertible Structure Spectrum — From Debt to Equity



Source: Citigroup Convertibles.

Original issue discount (OID) and premium redemption convertibles

Original issue discount convertibles and premium redemption convertibles are near identical structures. In the former the issue price is below par and it is redeemed at par, in the latter the issue price is par and it is redeemed above par. In both cases the probability of conversion is lower than a conventional convertible issued on the same premium, as the share price appreciation called for to make conversion optimal is greater. For example in a premium redemption structure with 110% redemption price, parity needs to be over 110%, compared with 100% in a conventional structure, before a holder would elect to convert rather than opt for redemption at maturity. Because of the lower probability of conversion these bonds tend to be nearer the 'debt' end of the debt/equity spectrum.

Put features

Zero coupon and OID convertibles often carry investor put options, with the put price set to the accreted price of the security on put date.

Call protection

It is quite common to find cases in which an unconditional call occurs simultaneously with and at the same price as an investor put. In these cases the 'matching-put-and-call' date can be looked upon as the effective maturity date of the security, since the circumstances in which it would not be rational for holders to exercise their put are likely to be those in which the issuer would be inclined to exercise the call. In cases where the zero coupon convertible does survive a matching-put-and-call it tends to trade close to parity or be voluntarily converted by holders on income grounds.

Contingent features

A contingent conversion feature limits the investor's ability to convert. The incorporation of such a clause in the terms of an issue is generally against the investor's interest. Contingent interest payment features allow the payment of a small amount of interest to the convertible bondholder and is triggered on the average market price of the convertible reaching a specified level.

From the investor's perspective

Zero coupon and OID bonds are frequently more defensive instruments than coupon convertibles because of the deep discount or premium redemption feature that they generally possess. Figures 10, 11 and 12 compare a notional zero coupon premium redemption convertible and a notional conventional convertible.

Figure 9. Zero Coupon Bond with Premium Redemption Structure

Issue Price	100
Coupon	0%
Redemption Value	120
Maturity	4 years
YTM	4%
Conversion Ratio	14 shares per bond

Source: Citigroup Convertibles.

Figure 10. Plain Vanilla Convertible Structure

Issue Price	100
Coupon	3%
Redemption Value	100
Maturity	4 years
YTM	3%
Conversion Ratio	14 shares per bond

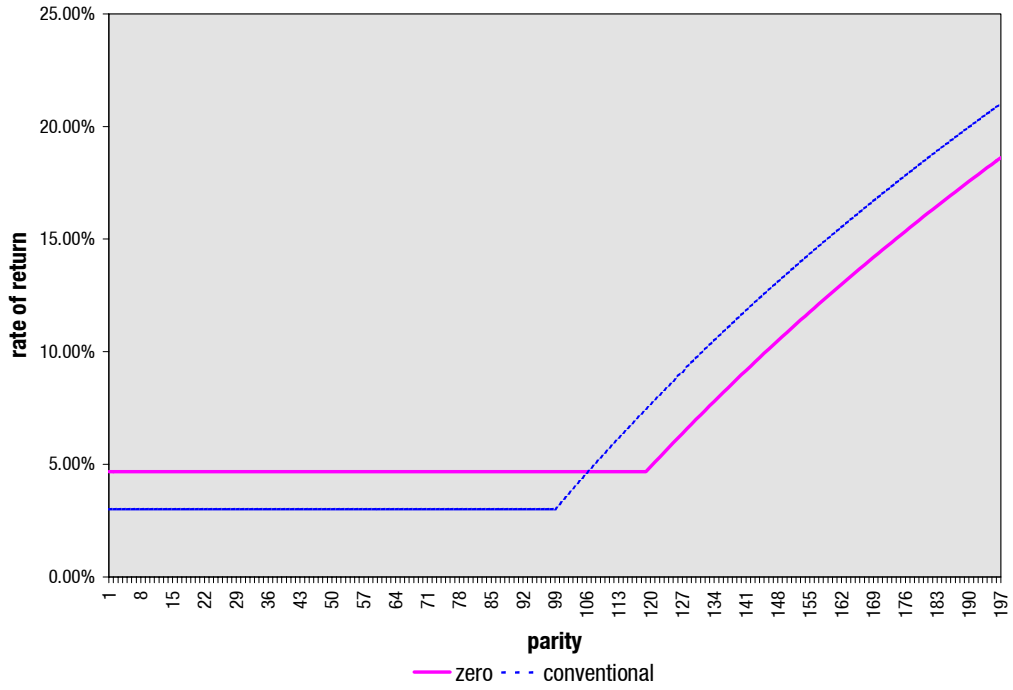
Source: Citigroup Convertibles.

Given the same YTM, the coupon-bond has a higher probability of being converted at maturity. If at maturity parity is 106, the coupon-bond will be converted into the underlying shares as the redemption price of 100 is below parity.

The zero coupon bond, on the other hand, will be redeemed at 117 in this instance. In other words, the '*effective conversion price*', the price at which the investor is indifferent between redemption and conversion, is much higher on the zero coupon, premium redemption convertible than on the coupon-convertible.

Figure 12 shows the payoff of the two structures. The defensive character of the premium redemption structure is illustrated by the fact that it does better than the conventional convertible in negative scenarios and less well when the share price is strong.

Figure 11. Zero Coupon, Premium Redemption Convertible — Rate of Return to Maturity



Source: Citigroup.

From the issuer's perspective

Major motives for issuing zero coupon and OID bonds lie in the tax and cash-flow advantages of the structure. Although no cash interest is actually paid, in many tax regimes the issuer can deduct the notional accretion on the convertible from taxable profits for tax purposes.

A plain vanilla convertible compared with a bond + warrant

Though a convertible can be thought of as a combination of a straight bond and a call option, there is a difference between buying a convertible and buying a 'bond cum warrant' issue (a bond issued with a long maturity call option attached). A bond cum warrant package can be usually stripped into its components and traded separately in the secondary market. A convertible is a 'package' and the call is embedded in the instrument so that investors can only own the embedded option by buying the whole instrument. Investors in a bond cum warrant can typically exercise their option by subscribing cash instead of bonds leaving the bond portion in existence. For a convertible, this is not the case.

Convertible preferreds

Convertible preferreds are a common structure in the US convertible market. The instrument is a preferred stock that pays a fixed dividend (usually quarterly) and carries rights of conversion into the issuer's ordinary shares.

In many cases, convertible preferreds are not redeemable. The issuer is not obliged to return any principal value back to the holder, but will have the obligation to pay the dividend indefinitely. Owners of convertible preferreds have a lower claim on the assets of the issuer than convertible holders, but a senior claim to ordinary shareholders.

In the United Kingdom a structure whereby the convertible bond is convertible into preference shares which then automatically convert into ordinary shares, is sometimes seen.

Mandatory preferred stocks

DECs

DECs stands for '*dividend enhanced common stock*' or, in the case of exchangeable DECs, '*debt exchangeable for common stock*'. A DECs is typically structured as a convertible preferred share that pays a fixed quarterly dividend. The yield at issue is invariably higher than the current yield of the underlying common stock. A DECs will automatically convert into the underlying ordinary shares of the issuer at maturity; in some cases a DECs can also be converted prior to maturity.

As with a traditional convertible security, the coupon and premium are set at issue. The term '*conversion premium*' has a different meaning for a DECs, however. The conversion ratio of a DECs varies according to the level of the underlying share price at the date of conversion. The '*true*' premium is a moving target. By convention, the premium quoted is that based on the lowest conversion ratio (or highest conversion price) that could apply. DECs typically have a maturity of three to four years.

Adjusted conversion ratio

The number of shares received upon conversion depends on the price of the underlying shares at maturity or in cases where early conversion is possible, at the time of conversion. The minimum conversion price is normally the share price at issue and the maximum conversion price is typically some 25% higher. The issue price of a DECs is sometimes the price of the share at issue though many now have some other issue price such as 50 or 100 (in the appropriate currency).

The example below assumes the issue price is the share price at issue.

The conversion price will be set according to the following rule:

- When the underlying share price is at or below the share price at issue, the conversion ratio is 1:1; one preferred share is convertible into one ordinary share.
- As the share price moves between the price at issue and the maximum conversion price, the conversion ratio is adjusted downwards and a preferred share becomes convertible into less than one ordinary share. The ratio is set such that the value of the shares delivered on conversion equals the share price at issue.
- Above the maximum conversion price, the conversion ratio no longer falls and is fixed at the minimum level set at issuance. The figure quoted for premium at issue is based on this conversion ratio.

Figure 12. Conversion Ratio and Value of Shares Received on a DECs Issued at Share Price at Issue

Stock Price	Number of Shares Received	Value of the Shares Received
Stock Price < Issue Price	1	Stock Price at conversion
Issue Price < Stock Price < Conversion Price	Issue Price/ Current Stock Price	Issue Price
Stock Price > Conversion Price	Minimum Conversion Ratio (issue price/maximum conversion price)	Conversion Ratio * Stock Price at conversion

Source: Citigroup Convertibles.

Where the issue price of the DECs is other than the share price at issue the conversion ratios in the different share price ranges need to be adjusted accordingly. For example if the share price at issue is US$25 and the DECs issue price is US$50, the applicable conversion ratio will be twice that in the table above.

Total return analysis

Figure 13. DECs Payoff Chart

Source: Citigroup Convertibles.

The ex post facto performance characteristics of a DECs are as follows:

Below the issue price:

- Conversion ratio = 1:1;
- Equity participation = 100%;
- The DECs outperforms the underlying share due to its yield advantage.

Between the issue price and the maximum conversion price:

- The conversion ratio decreases towards the minimum;

- No new equity participation;
- The total return of the DECs can still exceed that of the share due to the dividend advantage

Above the maximum conversion price:

- Conversion ratio set to minimum;
- The DECs underperforms the underlying common stock;
- There is positive upside participation.

Many investors perceive a DECs as a form of ordinary share where an element of equity participation is sacrificed in exchange for a higher yield. A DECs is usually non-callable for life.

PERCs

PERCs (*preferred equity redemption cumulative stock*) are typically structured as mandatory preferred convertibles with a maturity of three to four years.

Adjusted conversion ratio

The number of shares received upon conversion depends on the underlying share price at conversion relative to the 'cap level' set at issue. A PERCs structure offsets a higher yield against lower upside participation. As the underlying share price rises above a pre-set cap level, a PERCs becomes convertible into fewer and fewer underlying shares, keeping the total return payoff constant. The conversion ratio is calculated as:

Figure 14. Conversion Ratio on a PERCs

Stock Price	Shares of Common Stock Received
Stock price > Cap Price	Cap Price / Stock Price at Conversion
Stock Price < Cap Price	1

Source: Citigroup Convertibles.

Under the cap level, one preferred share is convertible into one underlying share so that the equity participation is 100%.

Above the cap level, the conversion ratio is below 1:1. One preferred share is convertible into less than one share of the underlying, so that the equity participation is limited.

Figure 15. Total Return Analysis for a PERCs

Source: Citigroup Convertibles.

Total return analysis

Under the cap level:
PERCs outperform the underlying common stocks due to the dividend advantage.

Above the cap level:
The total return of the PERCs is kept constant. The PERCs no longer has sensitivity to the rising share price, so above a certain level the share will deliver a superior return, in spite of the dividend advantage of the PERCs.

Exchangeables

Exchangeables are bonds issued by one company that exchange into the shares of a different company. They can be issued in both mandatory and non-mandatory form.

From the issuer's perspective

Exchangeable bonds can permit a company to dispose of or monetise a shareholding in another company. Not surprisingly, the justification for issuance bears a strong resemblance to that for any convertible. If the issue remains unconverted, the issuer will have secured low cost funding. If it gets converted, the issuer will have succeeded in disposing of the stake at a premium to the price that ruled at the time of issue. In many tax jurisdictions the disposal of a stake by means of an exchangeable bond enables the issuer to defer the crystallisation of tax liabilities on the sale.

Governments have also considered exchangeables as an effective way of monetising shareholdings as part of privatisation programmes. The exchangeable route can permit progress on a privatisation plan to be made even at times when the equity market would not be receptive to a pure equity offering.

From an investor's perspective

Exchangeable bonds present different valuation challenges to normal convertibles. Three major issues dominate: correlation, ring fencing, and forewarning.

Correlation

It is clear that if the issuer and underlying companies are one hundred percent correlated, there is no difference between the exchangeable bond and the convertible. Where there is a degree of independence there are more default scenarios in that either the issuer of the underlying company can default. In the event of underlying entity default the payoff is *bond floor* compared with *recovery rate* in the convertible.

Ring fencing

The payoff of the structure in the case of issuer default, no ring fencing and no forewarning is the same as that of a convertible (*recovery rate*). In the case of ring-fenced convertibles the payoff on default of the issuer is *max (parity, recovery rate)*.

Forewarning

With perfect forewarning of issuer default, the payoff of the non-ring-fenced convertible is the same as that of the ring-fenced convertible *max (parity, recovery rate)*. As stated above, the payoff in the case of no forewarning is *recovery rate*.

It has been found possible to adapt many convertible models to incorporate most of these features. In general zero forewarning is implicitly assumed, however, which possibly penalises the non-ring-fenced deals unfairly.

Reset features

A convertible in which the terms of conversion are subject to adjustment based on the behaviour of the price of the underlying share is sometimes termed a reset convertible. Reset clauses can be included in the terms and conditions of many convertible structures, however. Reset features allow for a change to the conversion price of a convertible in the event of share price depreciation (downward reset) or appreciation (upward reset) on a certain pre-specified date or dates.

Downward reset clauses allow for an increase of the conversion ratio in the event that the underlying share price is below a specified level on (or shortly before) the reset dates: the investor will be given more shares on conversion as compensation for share price weakness. The new conversion price is typically based on the average share price level over a specified period shortly before the reset date. In most cases the average is adopted as the new conversion price. Disregarding movements in the share price between the averaging period and the reset date, and assuming the average is not below the minimum conversion price discussed below, parity is set at 100%.

A reset clause specifies a reset floor, which is the minimum level to which the conversion price may be reset: even if the average share price goes below this level, the adjustment of the conversion price will be limited by this floor.

Sometimes there is also the possibility of an upward reset of the conversion price in the event that the underlying share price is above the ruling conversion price on (or shortly before) specified reset dates: an investor will be given fewer shares on conversion as they have appreciated in value. Such structures are unusual, however. Generally, even for bonds where the conversion price can be reset up or down, the level of the conversion price set at issue will be the cap for an upward reset.

The delta on a reset convertible security tends to rise as the underlying share price falls towards (and below) the minimum reset level and therefore gamma will be negative. This feature can create substantial pressure on the share price as arbitrageurs continue to sell shares to cover their increasing exposure to the underlying share price, accelerating the share price decline in the process.

The DECs structure mentioned above falls under the general heading of a reset convertible. It is a mandatory reset convertible with one reset at maturity.

Floating rate convertibles

Floating rate structures are not common. Having a floating rate coupon does have some merits however, particularly for issuers who prefer variable rate financing and would otherwise need to use the swaps market to convert a convertible bond's fixed coupon into floating. Because the life span of a convertible is less predictable than that of other bonds, specifying such a swap can be cumbersome. Some issuers have a natural inclination to prefer variable funding due to the nature of their business. For others it will be expectations that drive the preference. For example those who believe rates will remain low for longer than is implied by the yield curve would save on expected debt servicing costs by issuing an FRN.

From the investor's point of view the major disadvantage of floating rate convertible bonds is that the valuation problem is rendered more complicated. In some cases it may be possible to identify an equivalent fixed coupon bond for valuation purposes. Where there are calls, however, there is no accurate way of doing this; it is necessary to create a table of the future expected coupons as implied by the term structure of interest rates. It may be necessary to model a perpetual FRN as one with a finite date, though using par as the 'redemption price' in such circumstances is arbitrary. There is a case for using the expected value of a perpetual (non convertible) FRN as the redemption price.

A feature of FRNs is that the bond floor tends to be much more steady over time than that of a fixed coupon convertible.

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Pitfalls and Protection

- ➤ The prospectus
- ➤ Pitfalls
- ➤ Other prospectus issues

The prospectus

As convertible investors do not physically own the shares into which they possess rights of conversion, they rely on the terms and conditions outlined in the bond's Prospectus and Trust Deed (or Indenture) for protection against occurrences that may be detrimental to their interests. These include standard covenants restricting the issuers from undertaking certain courses of action. Convertibles are vulnerable to certain occurrences over and above those of straight bonds, however. These fall into two general categories:

- Events that would tend to lower the fair premium of the convertible. One example of this would be a takeover for cash that leaves the bondholder with rights of conversion into cash, or near cash.
- Events, such as rights issues, that have a dilutive effect on the underlying share price.

The prospectus will also provide information on the dividend and coupon entitlements of a convertible bond.

Convertible pitfalls and protection

Special distributions to shareholders

Distributions that have the effect of reducing the share also reduce the value of the convertible unless there is some form of compensation to convertible holders. The convertible price reduction will be approximately equal to the amount of the distribution expressed in parity terms multiplied by its delta. The sensitivity of the value of the convertible to common dividends is well known, and convertible models take expected payouts into account. Unanticipated capital distributions such as special dividends however, will put convertible bondholders in a situation that is unfavourable and unexpected. In some cases, convertible bondholders may be forced into early conversion in order to participate in the distribution.

Most modern convertible prospectuses contain language designed to protect holders against capital distributions. The definition of a special dividend in Europe generally falls into one of three categories:

- In some issues the prospectus defines a capital distribution as dividends in excess of a certain percentage of the previous year's payout, (or sometimes the highest annual payout over a certain number of prior years). Sometimes the 'permissible payout' is based on a compound growth rate since issue.
- In other cases payouts that push the dividend yield beyond a specified limit are defined as capital distributions (with variations for whether a share price average is used or share price at time of payment). Once the payment has satisfied the condition, the dilution compensation often looks back to the previous year's payout, rather than taking the excess over the yield threshold.
- In some cases there is 'distributable profits' rule, which states that only distributions in excess of earning per share are capital distributions. This category can be particularly detrimental to bondholders, especially if the current payout ratio is not high. Furthermore the 'distributable profits' rule is sometime cumulative, in essence permitting issuers to payout retained earnings since the launch of the convertible without triggering a change in the conversion terms.

Anti-dilution provisions

Anti-dilution provisions cover a range of situations that involve dilution of the underlying share price. The provisions will stipulate the situations in which convertible holders are compensated for a dilutive event. Typically this will involve an improvement in the conversion terms according to a formula. The intention is generally to increase the conversion ratio such that parity (that is the equity value of the convertible) is left unchanged, after accounting for the fall in the share price resulting from the dilutive event.

Stock-split

Conversion ratios are almost always adjusted in case of the most straightforward of dilutive events, the stock-split. If the stock-split were on a one-for-one basis for example, the conversion ratio would be doubled.

Merger or takeover

In the case of a merger or takeover of the issuing company by another company, the treatment of the convertible bondholder will depend on the conditions of the prospectus or trust deed[23]. In some cases there is no protection.

In general, where there are provisions for a merger or takeover event, there is a distinction in treatment of a bid (mainly) for cash and one that is (mainly) for shares. In an all-share bid by a quoted company, it is generally considered reasonable for the rights of conversion to be transferred into the shares of the new entity on a basis equivalent to the terms of the deal (the '*see-through*' basis). The bidder would also assume responsibility for the coupons and repayment of the convertible, if necessary. There is no presumption as to whether such a turn of events will be advantageous for convertible holders. It will depend, inter alia, on the volatility of the new company relative to that of the old, the dividend policies of the new company and its credit status.

The danger in the event of a cash bid is that the exchange property of the convertible becomes cash. In this situation, the lack of potential movement in the exchange property would lower or extinguish the premium. A number of devices can be applied to address this situation. In some convertibles there is a 'ratchet' mechanism in which the conversion ratio is adjusted by a specified amount if the takeover takes place within a given time frame. In others there is an adjustment to the conversion ratio, which is based on the average premium of the convertible over a specified time period. Sometimes the takeover language also includes an investors' put at par, accreted price, or some other value. In the case of some exchangeable bonds there is provision for any cash proceeds to be applied to buying other (volatile) assets.

Income entitlement

In the European convertible market, a measure of standardisation now exists on the question of dividend entitlement. The general rule is that accrued interest is not paid on a convertible on conversion and the shares delivered on conversion will rank pari passu with existing shares. There are, however, a number of exceptions to this rule. In particular, if holders are 'forced' to convert by the sending out of a call notice, there is often language giving protection against the scenario in which a long period has passed since a convertible coupon has been paid yet converting bondholders have just missed a dividend payment. Some transactions specify dividend entitlement that amount to delivery of ordinary shares that are ineligible for one or more dividends. For example, the entitlement to dividends may be based on the financial year in which conversion takes place.

Clean-up calls

If a certain percentage of the bond has already been converted into shares, the issuer may be entitled to call any remaining bonds thus forcing conversion. The percentage will be often set at around 90% of the convertible issue size.

[23] Amongst other things. In some jurisdictions, laws and take-over codes also provide some protection to bondholders

Other prospectus issues

In some cases prospectus detail can confer additional value to a convertible. We refer here to two examples of this; hidden benefits in call conditions and hidden benefits in put conditions.

Call conditions in soft call bonds

In soft call bonds the trigger permitting a call is sometimes harder to achieve than is presumed. In some cases a bond is thought to be callable on a certain date (subject to condition) but the prospectus dictates that this is the earliest that a notice is dispatched. With a typical minimum notice period of 30 days the effect is to make the bond non-callable for an extra month. In other cases the trigger is based on the level of the share price over a number of days and this reckoning cannot start until the announced call date. This pushes the first day on which a call can become effective even further forward.

The most important considerations relate to the precise conditions that need to be fulfilled, however. In most cases the trigger is more complex and harder to achieve than a 'one touch' share price condition that is often erroneously assumed. There are two principle soft call rule types; 'days above', 'average'. Within the 'days above' category there is a further subdivision between those that require the days to be consecutive and those that allow the share to fall below the boundary provided it is above it on a certain number of days within a specified period. By far the most demanding condition is that which requires the share price to remain above a certain level for considerable number (say 30) of consecutive days. In some cases this is equivalent to a 'one touch' condition some 10% lower.

Trigger currency

It is possible to make a serious valuation error (in either direction) in cross-currency convertibles (those in which the currency of the share that that of the bond are different) by failing to note whether call trigger is specified in terms of the domestic share price of the share or the value of the share expressed in terms of the bond currency. A trigger in terms of bond currency is the more logical as an investor will know the level of parity that corresponds to the call condition being met. There are, however, many examples of cases in which it is the share price in domestic currency terms that counts.

Put dates

It is important to look closely at the precise wording of an investor's put right. Where a considerable notice period is required and the put notice is not rescindable, the effective put date is earlier than a superficial inspection might suggest, detracting from the fair value of the convertible.

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Convertible Pricing Models

- ➤ **Recursive techniques**
- ➤ **Two factor models**
- ➤ **Approximations using European options**

Recursive techniques

Most convertible pricing models employ a binomial tree (or similar) approach. This uses a recursive procedure in a manner similar to that employed in valuing American options. The approach can deal with most of the common features found in convertibles — it can capture not only the value of the early conversion right, but also calls, puts and other characteristics.

As with other options models, binomial trees deal with probabilities. It is easy to misunderstand the nature of these probabilities, however. They do not relate to the chance of certain events occurring in the real world, but are set such that the 'expected price' of the share at any given date is constrained to equal the theoretical forward price at that date, the forward price being determined by arbitrage arguments not expectations. These 'shadow' probabilities are referred to as '*risk neutral probabilities*'.

The tree works by dividing the life of the bond into specific moments in time, with a range of convertible prices considered for each. Apart from the final (maturity date) range each price is calculated from two prices from the chronologically succeeding range. The relationship between the price and the two prices from which it is composed is given by the volatility of the share and a drift factor.

One starts by associating a value for the convertible with each share price level at the maturity date of the bond. In general, for share price levels above the conversion price the value is parity and for share price levels below the conversion price it is 100%. One now simply works backward through the tree. The next stage will be one period nearer the present day, with the period length being determined by the term of the convertible and the number of steps chosen. A new distribution for this stage is established and a value is assigned to a range of outcomes. In some cases the value for the convertible associated with each node calculated in this manner will need to be replaced if some feature of the bond makes this appropriate. For example if the bond is puttable at 100 on a certain date, then all observations under 100 at this date will simply be replaced with 100.

This process continues until one arrives at the present day with a fair value for the bond.

Formulae for the share price outcomes at maturity, the probability of an up, the probability of a down and the drift rate per period are based on simple algebra and can be found in options text books.

Two factor models

One limitation of the binomial tree approach is that it allows the share price to follow a stochastic path, but treats all other inputs, such as bond yields, dividends and FX rates as being either predetermined (or dependant on the share price). Of these, the lack of a random element in the interest rate assumption is particularly significant limitation.

Models have been developed to allow more variables to be modelled, for example incorporating stochastic bond yields and bond yields that are correlated to equity prices. Generally they employ recursive procedures similar to those of simple binomial trees. The number of factors in a model refers to how many variables are treated as stochastics. A one-factor model varies just underlying stock prices, whereas a two-factor model takes account of movements in interest rates (for example) as well.

The major disadvantage of a two-factor model is its complicated nature and lack of transparency. In a one-factor model, it is necessary to input the following:

- An assumption of the Libor spread (or spread to Treasuries; the credit spread assumption).
- Dividends on the underlying share until maturity.
- A volatility assumption for the underlying stock.

With a two-factor model the number of assumptions increases. Inputs for the following are called for:

- Bond (or yield) volatility.
- Equity/Bond correlation.

An investor may have a feel for the volatility assumptions he wishes to employ for a share, but would have no intuition as to the appropriate bond volatility and correlation.

Approximations using European options

From an equity investor's perspective

We have established that the value of a convertible to an equity investor can be summarised as:

Convertible Price = Parity + Put Option Value + Value of Income Advantage

In simple, non-callable convertibles we can calculate the theoretical value by establishing valuations for the components:

- Parity is simply the conversion ratio multiplied by the current stock price expressed in the bond currency.
- The put option value can be calculated using the Black Scholes model. The put is interpreted as the right to sell a parity number of shares at the redemption price. Thus the model is set for a plain vanilla European put.
- The income advantage is calculated as the present value of the income advantage.

By adopting this approach, equity investors can obtain a very clear impression of what they are paying for when they buy a convertible at a premium. However, the approach fails when there is a good chance of voluntary early conversion or when there is a period in which the bond is callable. When the call is provisional, even approximations in which the first call date is treated as the effective horizon are unreliable.

From the bond investor's perspective

We showed that the value of a convertible to a fixed income investor can be summarised as:

Convertible Price = Bond Floor + Call Option Value

We can find the theoretical value of a non-callable convertible by calculating the values of its components:

- The bond floor value is calculated as the present value of the future coupon payments and the cash redemption value, discounted at the relevant Libor spread plus a credit spread.
- The call option value can be calculated using the Black Scholes model set for a vanilla European call, exercisable at maturity.

As with the 'share plus put' calculation, the major advantage of this approach is its transparency for investors. The problem is that the approach is only theoretically correct if the bond happens to be non-convertible and non-callable for life. The extent of the potential error depends on how different the terms of the convertible in question are to this basic description. If the bond is convertible at any time, the approach is deficient in that it ascribes zero value to the early exercise option. However where there is a significant income advantage in the convertible, the early exercise right is of little or no value anyway. In the case bonds with an unconditional call feature, the use of approximations can be relatively successful. Where there is a provisional call period, however, the application of the European option methodology breaks down.

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Appendix

Introduction

This appendix contains additional information on the following subjects: yield to maturity (YTM), bond floor, delta, gamma, vega, rho, theta, and fugit.

Yield to maturity (YTM)

YTM can only be calculated through a process of iteration. The formula below shows the relationship between the bond price, the (annual) YTM, the coupon and the redemption amount in a simplified case where there is an exact number of years until maturity of the bond and coupons are paid annually.

$$\text{Convertible Price} = \sum_{i=1}^{m} \frac{C}{(1+YTM)^i} + \frac{R}{(1+YTM)^m}$$

Where:

m = years to maturity;

C = coupon; and
R = redemption value.

In the case of the *Widgets Convertible EUR 4% 2007*, the YTM of the issue is that which solves the equation:

$$€1{,}000 = \sum_{i=1}^{5} \frac{€40}{(1+YTM)^i} + \frac{€1{,}000}{(1+YTM)^5}$$

Solving for YTM (through trial and error)

YTM = 4%

Bond floor

One formula that can be used to calculate a convertible's bond floor bears a strong resemblance to the YTM formula above.

$$\text{Bond Floor} = \sum_{i=1}^{m} \frac{C}{(1+d)^i} + \frac{R}{(1+d)^m}$$

Where:

m = years to maturity;
C = coupon;
R = redemption value;
d = discount rate (the risk free rate + a credit spread)

The formula applies where there is a whole number of years to maturity. A somewhat more complex formulation is required when there are fractional periods, though the principal of finding the discounted present value of the fixed payments is the same. When there are fractional periods, the value is 'dirty'. In order to quote it, we need to deduct the accrued interest and to express the result as a percentage of par.

The discount rate is calculated using the risk-free rate for the maturity of the bond, plus a credit spread that reflects the credit quality of the issuer. In Europe, it is common to adopt the swap rate (Libor) in the currency in which the convertible is denominated as the risk-free rate. It is necessary to make an assumption on the credit quality of the issuer.

If the euro-Libor rate (the risk-free rate) for the five-year, euro-denominated *Widgets* convertible is 5.423% and appropriate credit spread for *Widgets* is 100bp, the appropriate discount rate for the *Widgets Convertible EUR 4% 2007* is 6.423%.

Solving for the bond floor on the *Widgets Convertible EUR 4% 2007* at issue gives:

$$\text{Convertible Bond Floor} = \sum_{i=1}^{5} \frac{€40}{(1+0.6423)^i} + \frac{€1{,}000}{(1+0.06423)^5} = €899.098$$

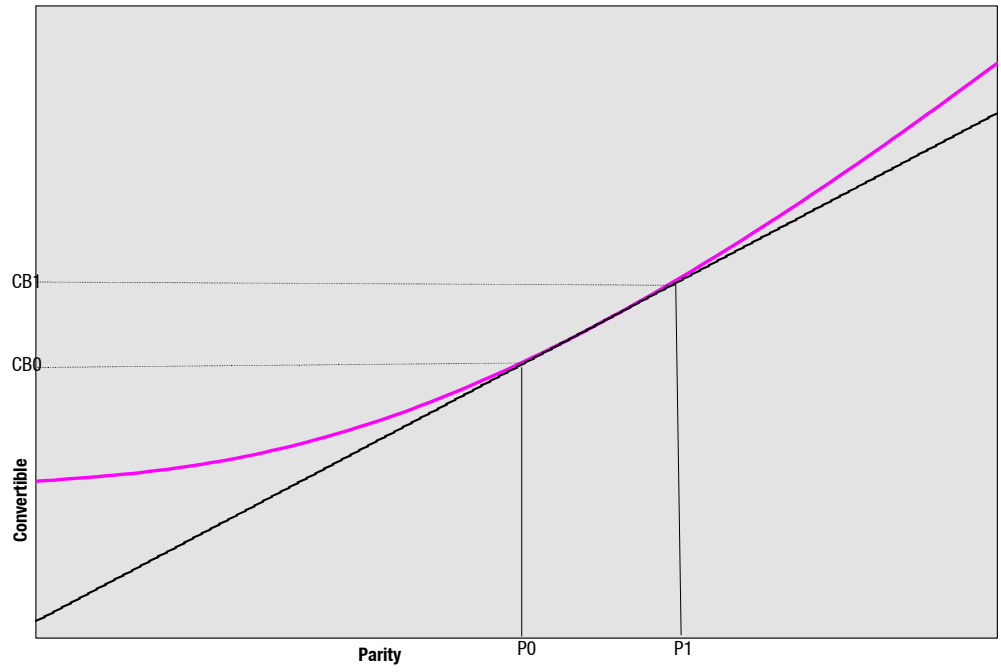
Expressed as a percentage of par, this is 89.91% (€899.1/€1,000).

Another method calculates the spot yield curve and discounts each future payment using the appropriate spot rate plus the credit spread.

Delta

Figure 17 displays the sensitivity of the price of the convertible to changes in parity. It shows that delta is the slope of the tangent drawn on the convertible price curve at the level of the current share price (parity).

Figure 16. Convertible Price Against Parity



Source: Citigroup.

Figure 17 shows how the tangent can be an accurate representation of convertible price movements only for small share price movements.

If parity moves from P0 to P1, then

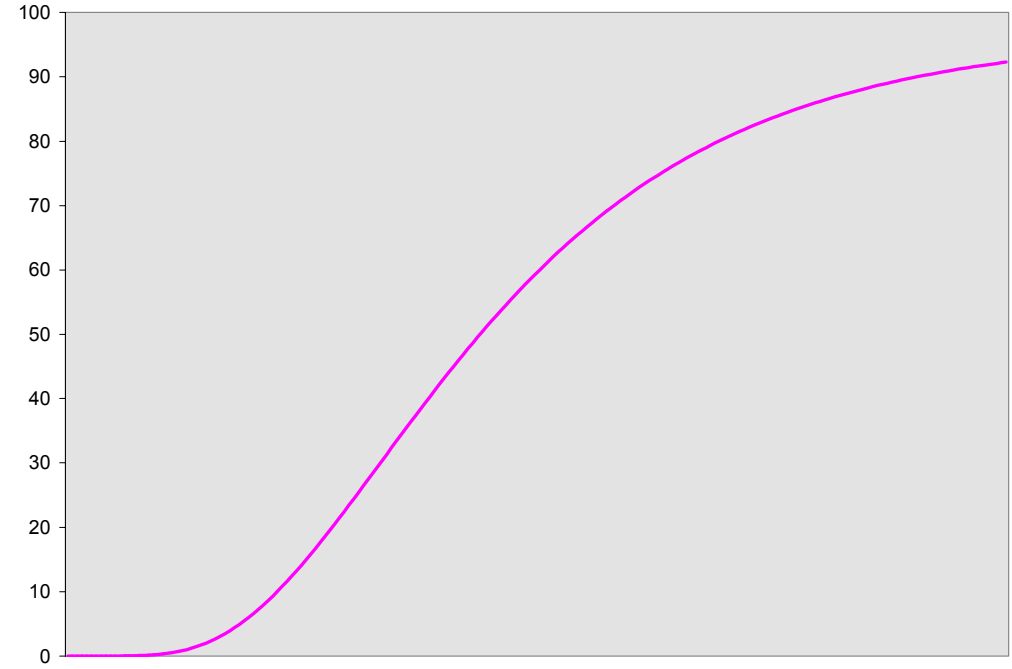
$$(P1 - P0) * Delta \approx CB1 - CB0$$

If we consider infinitesimal changes, *d*, then

*d (Parity) * Delta = d (Convertible Price)*

Delta = d (Convertible Price) / d (Parity)

Figure 17. Delta Against Parity



Source: Citigroup.

Gamma

Gamma is the rate of change of delta for movements in the underlying share price:

Gamma = d (Delta) / d (Parity)

Conventionally, gamma is expressed as the change in delta for a one-unit increase in parity.

We can interpret:

Delta as the first partial derivative of the convertible price with respect to parity; it measures the slope of the tangent drawn on the convertible price curve at the current level of parity.

Gamma as the second partial derivative of the convertible price with respect to parity; it measures the degree of convexity of the convertible price curve at the current level of parity.

Gamma = d (Delta) / d (Parity)

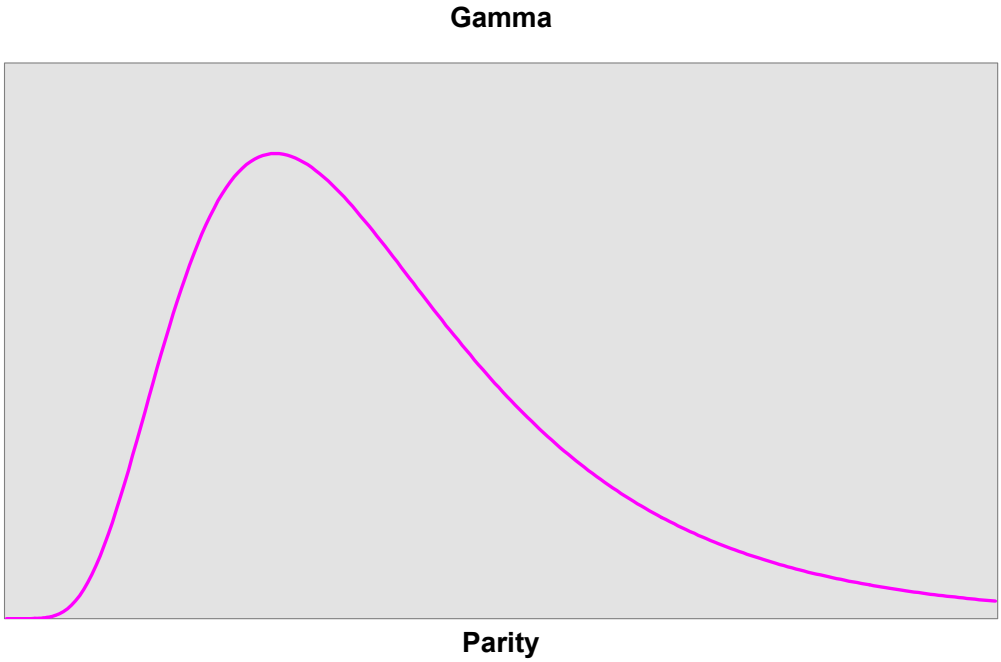
Gamma = d ²C / d P ²

Where **C = Convertible Price**

And **P = Parity**

For small stock price fluctuations, delta multiplied by the parity move can be a good approximation for changes in the convertible price. Adjusting for the effect of gamma is particularly important for larger share price movements, as the effect of convexity on the convertible price can be significant.

Figure 18. Gamma Against Parity



Source: Citigroup.

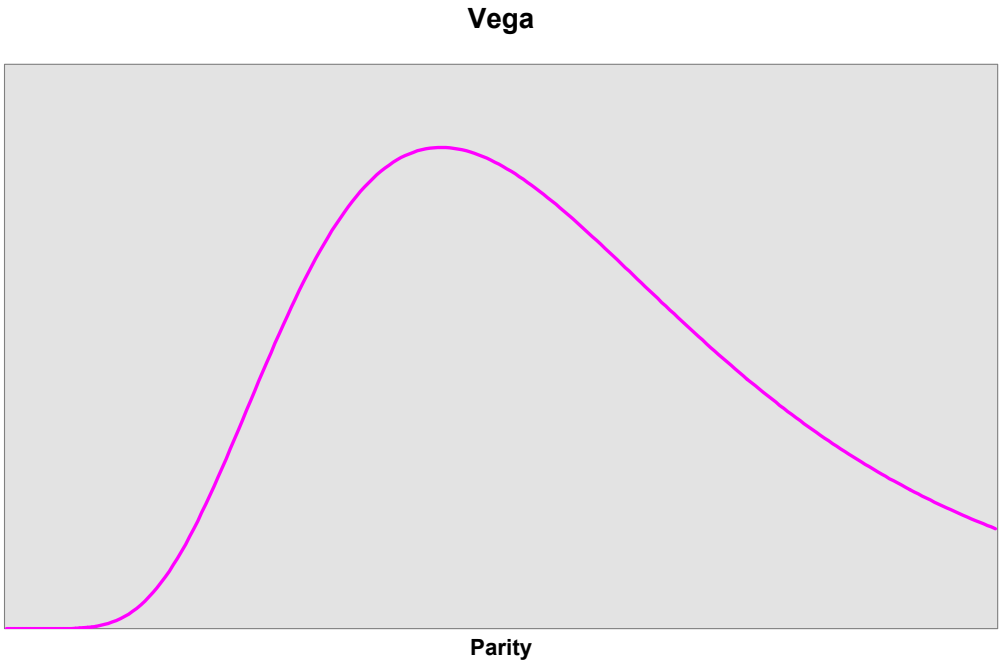
Gamma changes along the convertible price curve. Gamma is always positive in conventional convertibles, and it is at a maximum when the convertible is close to the money.

Vega

Vega is the sensitivity of the convertible price to changes in the volatility of the underlying stock. It can be expressed as follows:

Vega = d (Convertible Price) / d (Stock Volatility)

Figure 19. Vega Against Parity



Source: Citigroup.

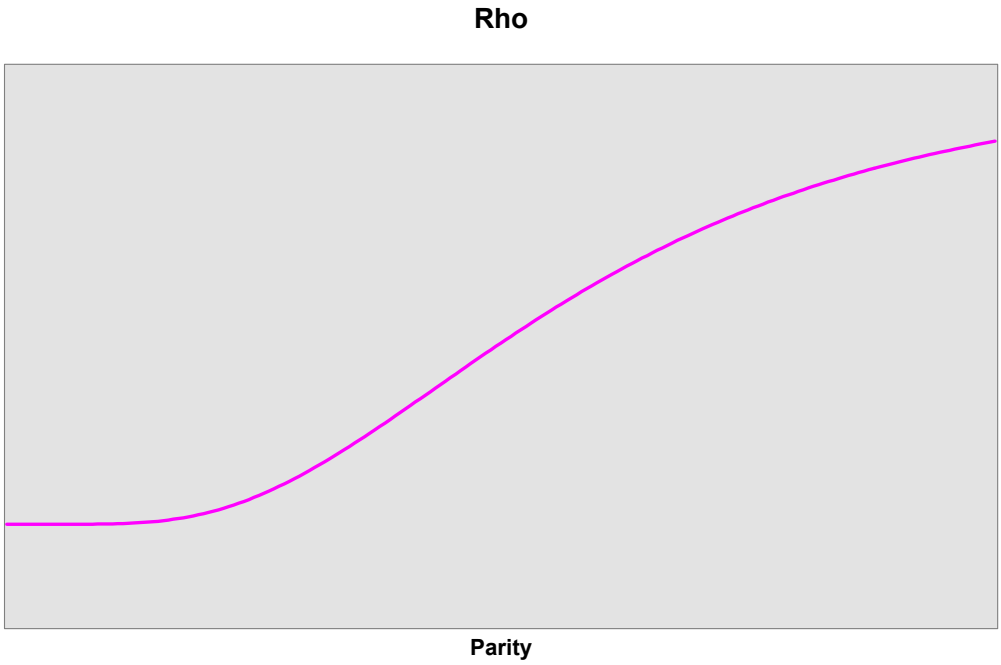
As can be seen from Figure 20, vega is always positive on a standard convertible and is greatest when the convertible is close to the money. A change in the stock volatility assumption may not have a material impact on fair value if the convertible is out-of-the-money or deep in-the-money.

Rho

Rho measures the sensitivity of the convertible price to movements in interest rates. Rho can be expressed as follows:

Rho = d (Convertible Price) / d (Interest Rate)

Figure 20. Rho Against Parity



Source: Citigroup.

Rho is always a negative number in conventional convertibles, as an increase in interest rates has a greater negative impact on the value of the bond floor, than it does a positive impact on the value of the embedded call option. As the share price falls, the bond floor becomes an important component of a convertible's valuation, the sensitivity of the convertible price to changes in interest rates increases.

Theta

Theta is the change in convertible price with the passage of time. Conventionally, it is expressed as the change in the convertible price for the passage of one day, all other things being equal.

Theta = d (convertible Price) / d (time)

As a convertible approaches final maturity, we see two opposite effects on the convertible price:

The value of the embedded call option decreases and so the convertible price decreases; and

The bond floor trends towards the redemption value over time. Convertibles trading below redemption value will experience upward bond floor 'drag to redemption'.

At-the-money convertibles will usually suffer from the first of these effects, with theta being a negative number. For out-of-the-money convertibles, the drag to redemption of the bond element can be the more potent influence.

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Glossary

Accreted value
The accreted value is the price at which an OID or premium redemption bond yields the same as it did when it was issued. If, for example, a 10-year zero-coupon bond were issued at a price of 50 to yield 7.2%, after five years the accreted value would be 70.7. At that price the bond would yield 7.2% to maturity at 100 after a further five years.

Accrued interest
This is the value of the accrued portion of the coupon on a convertible bond. Generally, it is the coupon amount divided by the number of days in a year, multiplied by the number of days since the last coupon was paid. To calculate accrued interest accurately, the bond's method of accrual needs to be known. Different methods predominate in different markets.

American-style option
This type of option allows the holder to exercise into the underlying asset at any time during the life of the option.

Anti-dilution provisions
These provide for an adjustment in the conversion terms in the event of special stock dividends, stock splits or other corporate events that can result in the dilution of the underlying share price.

At-the-money
A convertible is said to be at-the-money if the current share price is close to the conversion price.

Balanced convertible
A balanced convertible is a convertible that trades at a price where it is neither a pure equity substitute nor trading on its bond floor, but is balanced between the two.

Binomial tree
A binomial tree option-pricing model estimates the theoretical value for an option. Adaptations of the approach are commonly applied to convertible bonds. They take account of events such as puts and calls that take place during the life of the instrument.

Black-Scholes option-pricing model
The option-pricing model derived by Fischer Black and Myron Scholes is used to estimate the theoretical fair value of option contracts based on a range of inputs and assumptions.

Bond floor (or investment value)
The bond floor is the value of the straight fixed income element of the convertible if rights of conversion are ignored. The bond floor should support the price of a convertible if the underlying equity falls, thereby allowing holders of the bond to outperform holders of the equity.

Bond with/cum warrant
This is a straight bond issued with a long maturity call option attached. The bond cum warrant can be stripped and traded separately in the secondary market.

Breakeven
The breakeven calculation for a convertible measures the time taken for the bond's income or yield advantage to offset the cost to the investor of a bond's conversion premium. It is a simple measure that takes no account of dividend growth projections or discounting for present value.

Call feature (or call option)
A call feature gives a convertible issuer the right to redeem a convertible bond prior to maturity at a price determined at issue. Holders of convertibles who receive a call notice will generally have time to exercise their rights of conversion before repayment takes place; thus a call option can frequently be interpreted as required early conversion.

Clean price
The clean price is the price of a convertible bond quoted without accrued interest included. Most convertibles are quoted this way.

Clean-up call
When an issuer is entitled to call any remaining bonds if a certain percentage of the bond issue has already been converted into shares, it is termed a 'clean-up call'. The percentage is often set at around 90% of the convertible issue size.

Contingent conversion
A contingent conversion feature makes a convertible investor's ability to convert contingent upon some factor such as the share price attaining a specified level.

Contingent interest payment
Contingent interest payment features allow the payment of a small amount of interest to the convertible bondholder if the average market price of the convertible falls to a specified level.

Conversion premium
See premium.

Conversion price
At issue, the conversion price is the price at which shares are effectively 'bought' upon conversion, if the convertible is purchased at the issue price. It is calculated by dividing the issue price of the bond by the conversion ratio.

Conversion ratio
The conversion ratio is the number of shares into which each bond can be converted.

Convertible preferreds
These are preferred shares issued by a company that are convertible at the option of the investor into the common shares of that company. They pay a fixed dividend and are often issued in perpetual form.

Convertible price
This is the price at which the convertible is traded in the market. It is generally quoted as a percentage of par.

Coupon
The coupon is the interest payment per bond. It is normally quoted as a percentage of the face value.

Credit spread
The credit spread is the spread over the swaps curve (or sometimes Government bond curve) at which the issuer is assumed able to issue a straight bond that is otherwise identical to the convertible.

Cross currency convertible
A convertible that is denominated in a different currency to that of the underlying shares.

Current (or running) yield
Current yield is the income per unit of currency invested. It is calculated by dividing the coupon by the current convertible price.

DECs
DECS stands for *Dividend Enhanced Convertible Securities or Debt Exchangeable for Common Stock*. DECs are mandatory convertibles, typically issued as preferred stock paying quarterly fixed dividends.

Delta
Delta is a measure of the sensitivity of the convertible bond price to share price movements. It is defined as the expected change in the convertible price for a small absolute change in parity.

Denomination
This is the minimum size in which the bond can be traded.

Dirty price
The dirty price is the clean price of a convertible bond plus its accrued interest. It is the actual price an investor will pay for a bond.

Dividend yield
The dividend yield is an indication of the income generated by each share. It is calculated by dividing the annual dividend per share by the share price.

European option
This type of option gives the holder the right to exercise an option only on the maturity date.

Exchangeable bond
This is a convertible bond issued by one company that can be converted into the shares of a different company.

Gamma
Gamma measures the sensitivity of the convertible bond's delta to share price movements. It is the change in delta for a one-point change in parity.

Greenshoe
The Greenshoe is an over-allotment option that allows an underwriter to increase the number of bonds issued, typically by 10%-15%, when there is strong demand for an initial offering.

Hard call protection
A period of time specified in the indenture of a bond during which the issuer is not allowed to call the bond from the investor under any circumstances.

Hedge ratio
A convertible bond's hedge ratio is also referred to as 'delta'. The hedge ratio shows the equity sensitivity of a convertible bond and enables an investor to calculate how many shares they would need to sell to hedge their equity exposure.

High-yield convertible
If the share price falls dramatically, leaving the convertible so deeply out-of-the-money that its equity component becomes immaterial, it is sometimes referred to as a high-yield convertible. Issues for sub-investment grade companies are also referred to as high-yield convertibles.

Implied volatility
Implied volatility is the convertible pricing model volatility input used that brings the fair value of a convertible into line with its market price.

In-the-money
A convertible is said to be in-the-money if the current share price is greater than the conversion price.

Issue price
The issue price is the price at which convertible bonds are sold to investors at issue.

Mandatory convertible
This is a convertible in which the bondholder is obliged to convert into the underlying equity.

Maturity
The maturity date is the final redemption date of the bond.

Nominal value
This is the face value of the bond. It is often 1,000 of the relevant currency in the Euroconvertible market and ¥1,000,000 in the Japanese and Euroyen markets. The current price, issue price and redemption price of most convertibles are expressed as a percentage of the nominal value.

Original issue discount (OID)
A convertible issued at a discount to par is termed an original issue discount convertible.

Out-of-the-money
A convertible is said to be out-of-the-money if the current share price is below the conversion price.

Par
Par is the face value of a bond.

Par put convertible
A convertible in which the investor has a put option prior to final maturity at par.

Parity
Parity is the market value of the shares into which the bond may be converted. It is calculated by multiplying the conversion ratio by the current share price expressed in bond currency terms. It is normally expressed as a percentage of a bond's nominal value.

PERCs
PERCs stands for *Preferred Equity Redemption Cumulative Stock*. PERCs are a mandatory convertible bond structure that caps upside participation in a stock's performance.

Premium
A convertible's premium is the percentage by which the market price of the convertible bond exceeds parity. It represents the extra cost an investor must pay to buy the shares a bond converts into via a convertible. It is calculated by subtracting parity from the convertible price and is expressed as a percentage of parity.

Premium put convertible
A convertible in which the investor has a put option prior to final maturity with a put price above par.

Premium redemption structure
This describes a convertible bond that is issued at par but redeems at a premium to par.

Put feature
A put gives investors the option to sell back the convertible bond to the issuer at a fixed price on a given date or dates.

Ratchet
In some convertibles there is a ratchet mechanism in which the conversion ratio is adjusted by a specified amount if a takeover takes place within a given time frame.

Redemption price
The redemption price is the price at which the issuer must redeem bonds at maturity.

Reset date
The date on which a change of conversion terms takes place on a reset convertible is termed the reset date.

Reset features
Reset features allow for a change in the conversion price of a convertible in the event of share price depreciation (downward reset) or appreciation (upward reset) on certain specified dates.

Reset floor
The limit below which the conversion price on a reset convertible cannot fall.

Reset period
In most reset convertibles, the share price upon which the new conversion price is based is calculated by reference to the average share price observed in a specified reset period.

Rho
Rho measures the sensitivity of the convertible price to movements in interest rates. It is expressed as the change in the convertible price for a one basis point move in interest rates (a parallel shift in the yield curve).

Risk premium
The risk premium is the difference between the convertible price and the bond floor expressed as a percentage of the bond floor.

Soft call (or provisional call)
This is a period of time during which the issuer may only call the bond if the share price has traded above a predetermined premium to the conversion price for a set period of time. This predetermined premium is known as the call trigger. The call trigger is often stated as a percentage of the conversion price; thus 'subject to a 140% trigger' means that the call trigger is 140% of the conversion price.

Step-up coupon
This is where the coupon level increases at a future date. This can be a contingent event on for instance, a credit rating downgrade.

Theta
Theta is the change in the convertible price with the passage of time. It is expressed as the change in the convertible price for the passing of one day, other things being equal.

Vega
Vega is the sensitivity of the convertible price to changes in the volatility of the underlying stock. Vega is the change in the fair value of the convertible for a one percentage point change in the assumption for stock volatility.

Volatility
Share price volatility is a measure of the dispersion of share price returns. It is defined as the annualised standard deviation of returns. The extent to which the underlying share price has fluctuated over a certain period determines the historical or observed volatility. The assumption for future share price volatility is an input for convertible valuation.

Yield advantage
The yield advantage is the difference between the current yield on the convertible bond and the stock dividend yield.

Yield to maturity

Yield to maturity (YTM) is the discount rate that equates the current market price of a straight bond to the present value of its future cash flows.

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