Convertible Securities

An Investors' Guide

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Deutsche Bank

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Editorial Note:

We would like to thank Peter Darrell, Julian Moore and Jonathan Poole for their expert technical advice on this publication.

We also thank the European trading team of Simon Garcia, Andy McDonnell and Steven Roth for their patience and help in answering our many market specific questions.

Lastly, this new Guide would not have been possible without the tireless and good-humoured editorial support of Clodagh Muldoon, one of our junior European Analysts.



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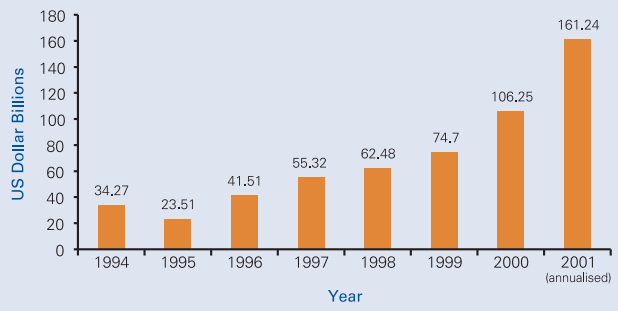
1. Convertible Securities - An Asset Class Grows Up

We published our first Investors' Guide to Convertibles in February 1997. Since then, a great deal has happened in the asset class. Fortunately for everyone involved in the product, the developments have been generally positive, and convertibles are now firmly established as a mainstream financing vehicle for corporates in every region. We believe they have become among the most exciting securities for dedicated investors, fixed income funds and hedge funds. Market developments in 2000/2001 have also drawn attention to the attractions of convertibles for equity investors, who were previously only active in the Asia Pacific markets.

The purpose of this updated Guide is to bring everyone interested in convertibles up to date with the asset class as it currently stands.

It is clear from Figures 1 and 2 that global convertible issuance has been very strong over the past six years, with difficult market conditions in years such as 1998 and 2001 failing to make a dent in the upwards march.

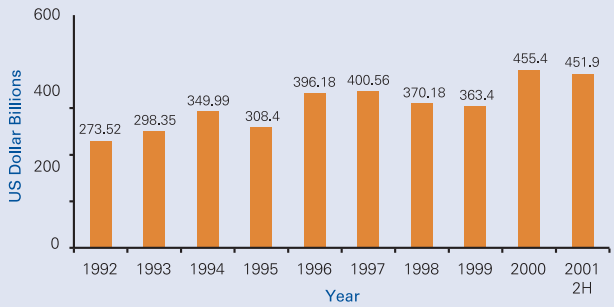
Fig 1: Global Market Issuance in USD



Source: Deutsche Bank Convertible Research

The general level of equity prices has affected the market cap of the product, but the total as of 2H 2001 of USD 451.9 billion represents a very substantial global asset class. The growth in convertibles has been driven by a number of different factors. In the US, the world's largest market, convertibles have survived the 'tech wreck' by attracting new higher credit quality companies through large, 0% coupon, long dated securities. Investment grade issuers have replaced the TMT corporates that fuelled the growth of the late 1990s.

Fig 2: Global Market Capitalisation in USD



Source: Deutsche Bank Convertible Research

Europe has also maintained its upward trajectory. Convertible issuance has come amidst corporate restructuring, as shareholder value considerations have forced a major programme of non-core holding divestments.

Asia has stayed on the map thanks to the Taiwanese technology sector and to some high profile 'jumbo' issues in Hong Kong and Korea.

The real underperformer since we last wrote in 1997 has been Japan, which has failed to keep pace with the global growth trend. Despite occasional moments of hope, the domestic market remains moribund, and the exchangeable revolution that has long been promised in Japan has yet to get off the ground.

The major difference between this updated Guide and the original is that we draw heavily on our www.dbconvertibles.com website. We also use real examples to illustrate our points as often as we can, rather than relying on hypothetical securities.

We have expanded our coverage of Asset Swaps and Credit Default Swaps, included whole new sections on how convertibles trade in the market today, on convertible documentation and also commentary on the new structures that have appeared since 1997.

2. Convertibles for Beginners

Convertibles have an unfortunate (and totally unjustified, in our opinion) reputation amongst some investors for being complex instruments. In its standard form, a convertible is simply a corporate bond which gives the holder an additional right to give up the bond in exchange for a fixed number of ordinary shares. At maturity, convertibles are worth either their cash redemption value or the market value of the shares into which they are convertible, whichever is the greater. Simple as that!

Although there are some exceptions to the plain-vanilla convertible structure, we believe it is important that all investors are familiar with the basic model. Throughout this section we will use the real example of the Dutch food company Ahold 4% 2005 EUR. In order to understand how this convertible works, we will split our analysis into two sections: A) the fixed terms and B) the market valuation.

A) The Fixed Terms

Ahold 4% 2005 EUR

Coupon	**4% (annual)**
Issue Amount	**EUR 920 million**
First Settlement	**19 May 2000**
Issue Price	**100.00%**
Redemption Amount	**100.00%**
Maturity	**19 May 2005**
Nominal Value	**EUR 1,000.00**
Conversion Ratio	**31.0463 (Nominal Value / Conversion Price)**
Conversion Price	**EUR 32.21 (Nominal Value / Conversion Ratio)**
Call Protection	**Hard Call 3 years**
ISIN	**XS0111182597**

So what do these terms mean?

Coupon (4%)

Coupons are the interest payments on the bond (convertible preferreds pay fixed dividends). This can be paid either annually, semi-annually or even quarterly. This amount is (almost always) fixed for the life of the bond. A 4% annual coupon on a EUR 1,000 nominal value bond indicates that on the coupon payment date each year the holder will receive EUR 40 in cash. As with normal corporate bonds, interest accrues between coupon payment dates according to the relevant market convention. These conventions are generally:

UK	**30 / 360 days**
Continental Europe	**Actual / Actual or 30 / 360 days**
Asia Pacific	**30 / 360 days**
US/Latin America	**30 / 360 days**
Japan (Domestic)	**Actual / 365 days** (in most cases)

An investor buying Ahold 4% 2005 EUR[1] for settlement 16 July 2001 for 100 (clean price) would pay the seller 100.633 or EUR 1,006.33 (ignoring any withholding tax). Accrued interest is paid up to (and including) settlement date (trade date + 3 days in all the Euroconvertible markets).

The EUR 1,006.33 is calculated as follows:

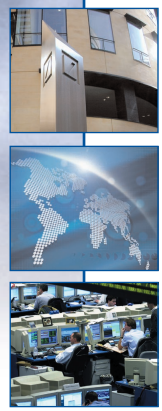
Settlement (16 July 2001) - Last Coupon (19 May 2001)

Accrued Interest	**= (57 days / 360 days) x EUR 40**
	= EUR 6.3333

Maturity (19 May 2005)

The date on which the issuer must offer to redeem the securities for their redemption amount. If the value of the

[1] Ahold 4% 2005 EUR compounds at 30 / 360



shares underlying the bond at maturity exceeds the redemption amount the holder will convert the bond into shares.

Conversion Ratio (31.0463 shares per bond)

The number of shares into which each EUR 1,000 bond is convertible. A conversion ratio of 31.0463 means that each bond can be converted into 31.0463 ordinary Ahold shares. The conversion ratio remains fixed throughout the life of the instrument, although it will usually be adjusted to account for stock splits, special dividends or other dilutive events, and 'reset' clauses. In fact , Ahold 4% 2005 EUR had an initial conversion price of EUR 33.02 that was adjusted as a result of a dividend paid (partially) in shares.

Conversion Price (EUR 32.21)

The price at which shares are effectively 'bought' upon conversion. Ahold 4% 2005 EUR is convertible into 31.0463 shares per bond. As the nominal value of the bond is EUR 1,000, the holder has paid EUR 1,000 for the right to convert the bond into 31.0463 shares. At maturity, if parity (share price x conversion ratio) is higher than EUR 1,000 the holder will convert into shares. As parity will only be greater than redemption amount if the stock is above EUR 32.21, EUR 32.21 is effectively the 'strike price', or conversion price. A convertible is 'in the money' if:

Share Price > Conversion Price

'Hard' Call Protection (3 Years Hard Call to 19 May 2003)

Most convertible bonds are issued with a period of call protection during which the issuer may not redeem (call) the bonds early. 'Hard' call protection is the period during which the bonds cannot be called under any circumstances. 'Provisional' protection is when the bonds can be called subject to the share price being above a certain level (see below). Call protection is important for investors as it guarantees the optionality of the convertible and whatever yield advantage it has over the underlying shares for a fixed period of time. The longer the call protection, the greater the benefit for investors.

'Provisional' (or 'Soft') Call Protection

Ahold 4% 2005 EUR does not have provisional call protection, but provisional call protection means that the bond cannot be called unless the stock trades above a specified level for a certain period of time. Usually, this level is expressed as a percentage of the conversion price (i.e. bond is callable if stock > 140% of conversion price). To prevent abnormal trading patterns triggering a provisional call, most convertible prospectuses state that the stock must trade above the trigger price for 20 or 30 days before the provisional call is activated.

The effect of call protection on convertible valuation is discussed more fully in Chapter 3.

B) The Market Valuation

This section examines the characteristics of the bond on a specific day (trade date 11 July 2001).

Secondary Market Valuation

Convertible Price	**121.75**
Parity	**113.78**
Conversion Premium	**7.00%**
Current/Running Yield	**3.285%**
Yield to Maturity	**-1.462%**

Underlying Stock

Stock Price	**EUR 36.65**
Stock Volatility	**33%**
Stock Yield	**1.5%**
Breakeven	**3.66 years**

Fixed Income Analysis

Credit Spread	**LIBOR + 160 bps (4 Year LIBOR = 4.65%)**
Bond Value	**91.91**
Risk Premium	**32.47%**

Let's look at what each of these numbers means:

Convertible Price (121.75)

In most markets, convertible bonds are quoted using the standard fixed income percentage of par methodology. Therefore, 121.75 means 121.75% of (in this case) EUR 1,000 or EUR 1,217.50 per bond (given a nominal value of EUR 1,000). France is an exception, where prices are quoted in absolute Euro / Franc amounts.

Most prices (outside France and US Preferreds) are 'clean', in that they do not include accrued interest. An investor purchasing the bond would actually pay more than EUR 1,217.50 to reflect the accrued interest in the bond.

Parity (113.78)

Parity is a very important term for understanding how convertibles perform. Parity is the market value of the shares into which the bond can be converted at that time. Like convertible price, it is also expressed on a percentage of par basis (except in France). 113.78 is actually a market abbreviation for 113.78% of EUR 1,000.

Parity = Number of shares per bond x share price
Parity = 31.0463 x EUR 36.65 = EUR 1,137.8

Parity is normally quoted as a percentage of par amount:

= EUR 1,137.8 / EUR 1,000
= 113.78% (or just 113.78)

Parity is crucial because it will influence not only the price of the bond (convertible price should not normally be less than parity), but also whether the bond will be converted at maturity. Table 1 shows how this works.

Table 1: What Happens to Ahold 4% 2005 at Maturity?

Stock Price at Maturity	Parity	Redemption Amount	Bondholders' Action
1. EUR 10.00	31.05	100	**Redeem for cash**
2. EUR 32.21	100.00	100	**Indifferent between cash and shares**
3. EUR 40.00	124.19	100	**Convert into shares**

Source: Deutsche Bank Estimates

1. In Scenario 1 the bondholder will not take shares worth EUR 310.5 (per bond) when EUR 1,000 is the cash redemption value.

2. In Scenario 2 the bondholder is indifferent between EUR 1,000 cash redemption value and EUR 1,000 in shares.[2]

3. In Scenario 3 the share price at maturity has risen to EUR 40 and parity is 124.19. An investor will convert into

[2] This analysis is simplified to exclude the final coupon payment. In reality, the redemption value is EUR 1,040 due to the final annual coupon payment, which will often be lost on conversion. An investor would usually take the cash in Scenario 2.

shares worth EUR 1,242 at maturity rather than redeem the bond for EUR 1,000.

Premium (7.00%)

Premium is related to parity. Premium is the difference between parity and the convertible bond price, expressed as a percentage of parity. Premium expresses how much more an investor has to pay to control the same number of shares via a convertible, rather than buying them outright.

Premium = (Bond Price - Parity) / Parity

$$= \frac{7.97}{113.78} \times 100\% = 7\%$$

An investor buying Ahold 4% 2005 EUR for EUR 1,217.5 controls 31.0463 shares per bond. But an investor buying 31.0463 shares in the market would only pay EUR 1,137.84 (31.0463 x EUR 36.65). The extra EUR 79.7 represents the convertible's premium.

Premium also gives a guide as to how a convertible will perform in relation to the underlying shares. Convertibles with low premiums should be more sensitive to movements in the underlying share price than convertibles where premium is high.

Very 'in the money' (see page 11 for definition) convertibles will sometimes be quoted in terms of their 'points' premium over parity. In the above example, points premium would be 121.75 - 113.78 = 7.97 points.

Current Yield (3.285%)

Investors should think of current yield in exactly the same way as dividend yield on the equity.

Current Yield (3.285%) is:

Coupon / Current Price of Bond
= 4/121.75
= 3.285%

Yield to Maturity (-1.462%)

The yield to maturity (YTM) is based on the price of the bond, the coupon payments to maturity and the final redemption amount. YTM takes account of the capital gain/loss on the bond at maturity.

When a convertible has a put before maturity, investors will also look at yield to put (YTP).

Breakeven (3.66 Years)

Breakeven is the length of time needed to amortise the premium paid to buy the convertible via its yield advantage over the underlying stock. We have explained above that investors in Ahold 4% 2005 EUR pay a EUR 79.66 'premium' to own the convertible rather than the shares themselves. But convertible investors receive extra yield on their investment. Every year, the convertible will pay EUR 40 in cash. Assuming a 1.5% dividend yield, the same cash outlay on the shares would have returned only EUR 18.26 (1.5% x EUR 1,217.5). We now have enough information to calculate 'convertible breakeven'.

Convertible investors receive EUR 21.74 more income than investors in the same cash amount of stock each year (EUR 40.00 - EUR 18.26). Breakeven calculates how long it takes for the EUR 79.66 premium to be amortised by the annual EUR 21.74 in extra yield.

Breakeven:

$$= \frac{\text{Cash Premium Paid}}{\text{Convertible Coupon - (Convertible Price x Stock Yield)}}$$

$$= \frac{\text{EUR 79.66}}{\text{EUR 40.00 - (EUR 1,217.50 x 1.5\%)}}$$

$$= \frac{\text{EUR 79.66}}{\text{(EUR 40.00 - EUR 18.26)}}$$

$$= \frac{\text{EUR 79.66}}{\text{EUR 21.74}}$$

= 3.66 Years

Some investors look at a simple measure of breakeven: current yield / dividend yield. But this is not really an accurate statement of the cash premium amortisation. In fact, breakeven analysis is today only applied to mandatory or other very 'equity-like' convertibles.

Bond Floor (91.91)

Bond floor is the value of the convertible as a straight corporate (i.e. non-convertible) bond. To calculate bond floor it is only necessary to know: (1) coupon, (2) maturity date, (3) redemption amount, (4) puts and (5) discount rates (the risk-free rate + credit spread).

At 91.91, the accretion to redemption at par and coupons would give a yield of 6.25%. This is exactly 160 bps over the risk-free rate of 4.65%. 6.25% is the YTM we would expect to find on comparable straight Ahold bonds.

The bond floor of a convertible should provide a price floor if interest rates and credit perceptions of the issuer remain unchanged.

Risk Premium (32.47%)

Just as premium expresses the premium investors pay to own a fixed number of shares via a convertible, risk premium refers to the premium of the convertible price over its bond floor. It could be thought of as the premium fixed income investors pay for the equity call option.

Risk Premium is:

$$\frac{\text{(Convertible Price - Bond Floor)}}{\text{Bond Floor}}$$

= (121.75 - 91.91) / 91.91

= 32.47%

How Convertibles Perform in the Market

The best diagram for understanding the performance of convertibles in the secondary market is shown in Figure 3 (below). Newcomers to the convertible market are strongly advised to familiarise themselves with this diagram, as it illustrates how convertibles perform in virtually all scenarios.

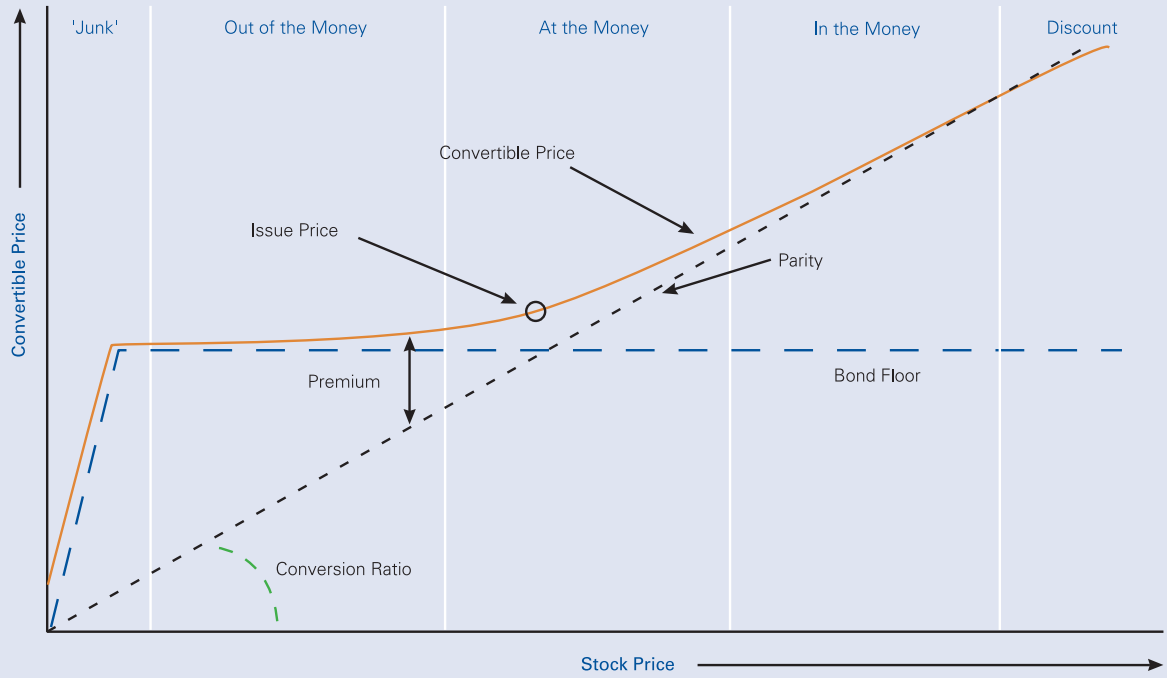
We break the diagram up into five main sections:

Working from left to right, we find:

i. **Distressed Debt ('Junk') Convertibles**
ii. **'Out of the Money' Convertibles**
iii. **'At the Money' Convertibles**
iv. **'In the Money' Convertibles**
v. **'Discount to Parity' Convertibles**

The expressions 'out of', 'at' and 'in the money' are loosely defined in the convertible market. Technically, they should be defined with reference only to the stock price and the conversion price, such that:

Fig 3: How Convertibles Perform in the Secondary Market



Source: Deutsche Bank Estimates

'Out of the Money'	**= stock price < conversion price**
'At the Money'	**= stock price = conversion price**
'In the Money'	**= stock price > conversion price**

However, the 'At the Money' category is usually broadened to include instruments whose stock prices are reasonably close to the conversion price.

i) <u>Distressed Debt / 'Junk' Convertibles</u>

Parity	**= 0 - 40**
Premium	**> 100%**
Delta*	**N/A**
Risk Premium	**< 5%**

(***Delta** is explained fully in Chapter 6 - it is a measure of the convertible's sensitivity to stock price movements).

When a convertible issuer's share price falls dramatically, or its ability to finance its debt obligations is called into question, the convertible enters the distressed debt category. The overriding concern for convertible investors, and other bondholders, becomes the creditworthiness of the company. Distressed debt or 'junk' convertibles usually trade with a large premium to parity, at the fixed income

value for the equivalent high yield instrument. The credit spread over the risk-free rate will be high to reflect the high probability of default. Unlike convertibles which are just 'out of the money', distressed bonds are often more sensitive to credit perceptions of the guarantor than to interest rates.

These convertibles' prices can sometimes be correlated almost 100% with the share price.

As with all high yielding debt, we believe 'junk' convertibles should be approached with caution and avoided altogether by investors without reliable credit research on the guarantor / issuer. The last couple of years have seen an increase in the number of high yield funds prepared to switch in and out of convertibles as high yield alternatives. This has brought greater efficiency into distressed convertible pricing.

Other considerations for assessing distressed debt convertibles include:

1. Subordination - The level of subordination of the bond will affect its 'recovery rate' (amount eventually paid back to bondholders on default). Watch out for non-quoted bank debt, assets and revenue streams that have been securitised, as well as the claims of holders of more senior bonds.

2. Accountancy and Transparency - As an understanding of the balance sheet will probably be the most important consideration, an investor needs to be sure that they have all the relevant items. Off balance sheet liabilities can be hidden quite easily in some markets. Hidden guarantees of related company liabilities (in Asia and Japan especially) can also be an issue.

3. Bankruptcy Laws - These vary hugely across the world. No distressed debt convertible investor should think of taking a position without a thorough grounding in the bankruptcy laws of the applicable legal jurisdiction.

4. Structured Subordination - This can occur when convertibles are issued from holding companies which own geared operating assets.

Fig 4: 'Out of the Money' Ahold 4% 2005 EUR

Source: Deutsche Bank Estimates

ii) 'Out of the Money' Convertibles

Parity	**= 40 - 70**
Premium	**> 35%**
Delta	**= 10% - 40%**
Risk Premium	**= 5% - 20%**

Unlike 'distressed debt' convertibles, 'out of the money' convertibles can (and often do) have perfectly creditworthy issuers. Their 'out of the money' status simply reflects the fact that the underlying share price has not performed well

since issue, and is still well below the conversion price. This means that parity will be well below 100. Remember that parity is:

$$\frac{\textbf{Stock Price x Conversion Ratio}}{\textbf{Nominal Value}}$$

So therefore parity must also be:

$$\frac{\textbf{Stock Price}}{\textbf{Conversion Price}} \textbf{ x 100}$$

Our sample bond Ahold 4% 2005 EUR was issued with parity at 80.37 (EUR 803.7 per bond) and a premium of around 24.4%. If the share price were to fall to EUR 16.10 (see Figure 4) parity would fall to around 50.0. So where would the convertible trade in the secondary market?

We recall that the fixed income value, or bond floor, of the convertible using the issuer's cost of debt (LIBOR + 160bps) is 91.91. This provides a floor below which the convertible should not trade. In fact, as Figure 4 shows, we expect the convertible to trade at a small premium to its bond value to reflect the time value of the (albeit out of the money) equity call option contained in the convertible. The exact convertible price is calculated using a binomial model, which is explained in Chapter 6. The actual theoretical value is 92.78.

Investors purchasing out of the money convertibles will profit under four different scenarios:

1. If the underlying share price rises significantly;

2. If interest rates fall (i.e. the bond market rallies) and bond floor rises;

3. If the market's perception of the credit quality of the company improves (the credit spread contracts and the bond floor rises); and/or

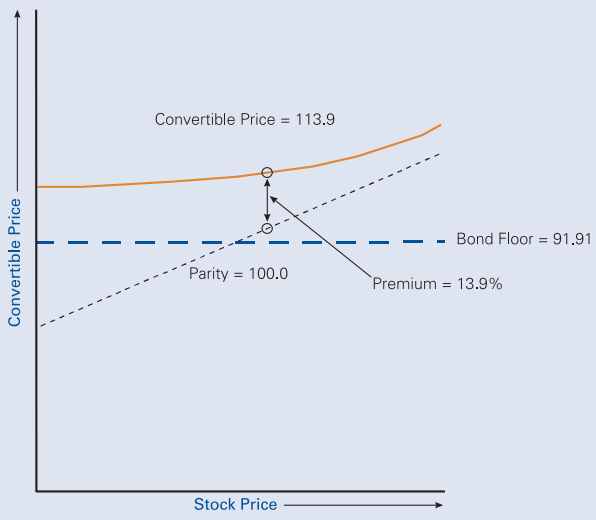
4. If the convertible's premium to its bond floor increases as a result of a general richening of convertible valuations.

'Out of the money' convertibles have become increasingly attractive to fixed income funds who switch straight corporate debt positions into these securities to take advantage of any sizeable rally in the underlying share price (see Section 3).

iii) 'At the Money' Convertibles

Parity	**= 70 - 130**
Equity Premium	**= 10% - 35%**
Delta	**= 40% - 80%**
Risk Premium	**= 20% - 40%**

Fig 5: 'At the Money' Ahold 4% 2005 EUR



Source: Deutsche Bank Estimates

'At the money' convertibles are often regarded as 'true' or 'balanced' convertibles, as they tend to have the asymmetric risk/return profile (upside participation with downside protection versus stock price movements) that appeals to dedicated convertible investors. They are also the most popular bonds with convertible hedge funds (see Chapter 6).

'At the money' convertibles have a higher delta (equity sensitivity) when the underlying shares rise than when they fall. This means that the convertible will participate in more equity upside than downside. It is clear from Figure 5 that as parity goes up, the convertible price line increases in steepness, whereas it starts to flatten as parity falls.

We can demonstrate the risk-adjusted profile of an 'at the money' convertible by examining how Ahold 4% 2005 EUR performs under different stock price scenarios when parity starts at 100. The values calculated in Table 2 are derived from a binomial tree convertible valuation model, which will be discussed fully in Chapter 6.

Table 2: Asymmetric Risk/Return Profile of Ahold 4% 2005 EUR when 'At the Money'

Stock Price	Parity	Theo. Convertible Value	Participation with Stock move
EUR 38.65	120	129.0	66.3%
EUR 32.21	100	113.9	0.00%
EUR 25.76	80	101.9	- 52.7%

Source: Deutsche Bank Estimates

When starting from an 'at the money' profile with parity at 100.00, Ahold 4% 2005 EUR participates in 66% of a stock price rise of 20%, but only 53% of a similar downwards move. This is the kind of asymmetric risk/return profile that dedicated convertible investors and hedge funds look for. Convertibles are almost always issued with an 'at the money' profile, with parity usually somewhere between 70 and 90.

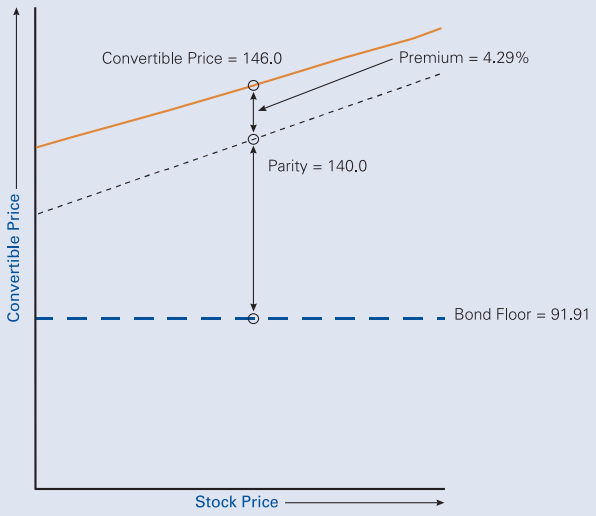
iv) 'In the Money' Convertibles

Parity	**= 130 +**
Premium	**= 0% - 10%**
Delta	**> 80%**
Risk Premium	**> 40%**

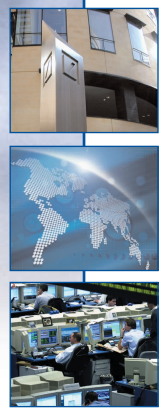
As the stock price rises above the conversion price (EUR 32.21 for Ahold 4% 2005 EUR), the convertible moves into the 'in the money' section of the main 'ski jump' diagram (Figure 3).

Very 'in the money' convertibles are almost certain to be converted at maturity. As they move further and further from their bond floor, the premium investors will

Fig 6: 'In the Money' Convertible Performance



Source: Deutsche Bank Estimates



be prepared to pay over parity decreases. In the money convertibles will not trade at a significant premium to parity unless either: (1) the bond has a very large income advantage over the underlying shares and/or (2) there is a long time until the first call date or maturity (giving significant time value to the put inherent in the convertible).

The value of the convertible's inherent put is the cash redemption of 100 (or other redemption amount) at maturity. The value of this put obviously declines as parity rises. The put at 100 is worth much less when parity is 140 than when parity is 100. When the convertible is a long way in the money the put is worth so little that an investor should pay only the present value of the expected income advantage over the underlying shares as premium.

'In the money' convertibles are far more sensitive to movements in the underlying share price than to movements in interest rates. Because they trade at such a low premium to parity, equity sensitivity (delta) is high. And because they trade at such a high premium to bond floor, interest rate sensitivity (rho) is low. This is demonstrated in Table 3:

Table 3: As Parity Rises: Delta Rises

Parity	Theo. Value	Bond Floor	Delta
60.00	93.94	91.91	21.87%
100.00	113.9	91.91	70.04%
140.00	146.0	91.91	92.04%

Valuation parameters for Ahold 4% 2005 EUR

Source: Deutsche Bank Estimates

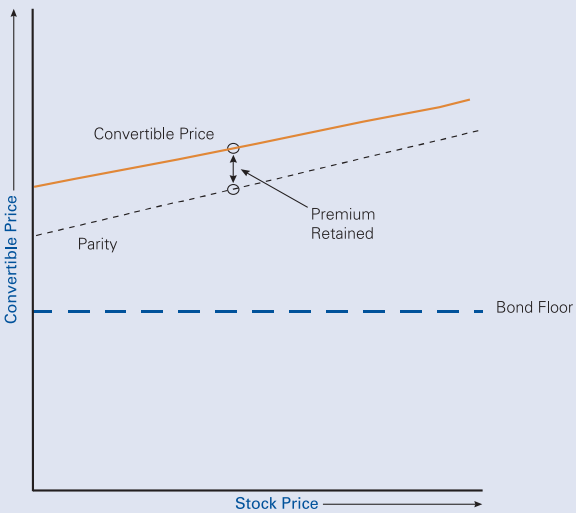
Call Protection

Almost all convertibles allow the issuer to call (i.e. to redeem) the bond *before* the maturity date. But of course if the convertible is 'in the money' investors will convert rather than accept the cash redemption. This call can sometimes be subject to a trigger, such as parity needing to be 120% or 130% before the call is activated.

The following diagrams demonstrate the effect of call protection on convertible valuations. Remember that call protection is 'hard' if the issuer cannot call the bonds under any circumstances, and 'provisional' if the issuer can only call the bonds if the stock / parity has risen above a trigger level.

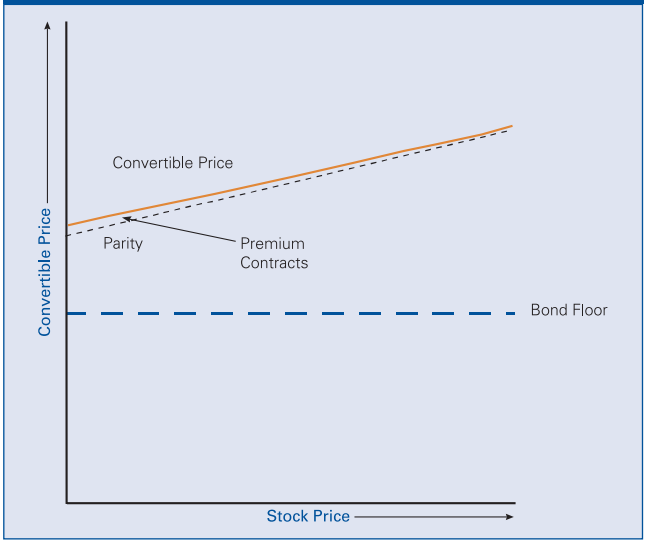
Figure 7 below shows how premium is retained if long call protection exists, whereas it collapses in Figure 8 where call protection has expired.

Fig 7: Call Protection Remains: Premium is Retained



Source: Deutsche Bank Estimates

Fig 8: Call Protection Elapsed: Premium Collapses



Source: Deutsche Bank Estimates

Long call protection is good for the holder of a convertible because:

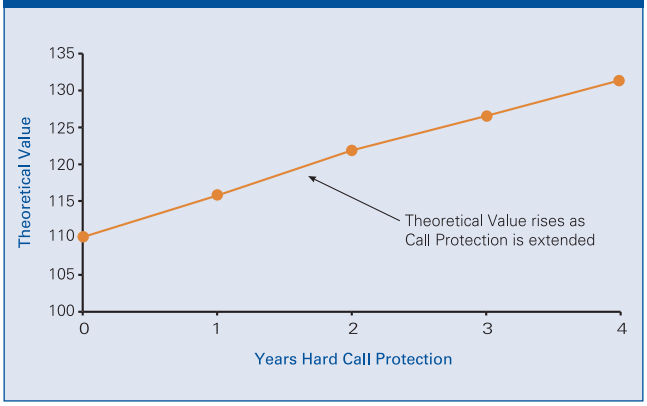
1. The optionality of the bond lasts longer; and
2. The income advantage of the convertible over the underlying shares lasts longer.

Points 1 and 2 mean that investors will pay more for a bond with longer hard call protection.

The effect of hard call protection on the theoretical value of a convertible is very significant. Figure 9 demonstrates how the theoretical value of Ahold 4% 2005 EUR rises as hard call protection is extended.

Convertibles with reasonable call protection remaining and a significant yield advantage over the underlying shares are extremely attractive to equity investors, because they offer upside participation with downside protection and yield enhancement.

Fig 9: Theoretical Value Rises as Call Protection is Extended



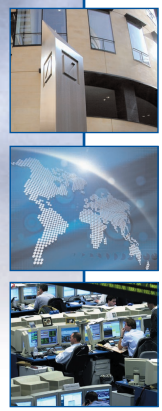
Source: Deutsche Bank Estimates

v) 'Discount' Convertibles

Parity	**High**
Premium	**< 0%**
Delta	**= 100% (can be > 100%)**
Risk Premium	**> 40%**

A 'discount' convertible is one in which parity is greater than the convertible price. Sticking with the example of Ahold 4% 2005 EUR, if parity rose to 140 and the convertible was trading at 138, the bond would be trading at a -1.45% discount to parity.

Why would a convertible trade at a discount to parity? It should be obvious that as convertibles are usually American style options (convertible at any time), a risk free profit could be made by buying the convertible, converting it immediately and selling the shares. The word 'immediately'



gives a clue as to why convertibles occasionally do trade at a discount.

In some convertible markets (especially in Asia) conversion into the underlying shares is not straightforward. In Taiwan, to take an extreme case, convertible securities are not directly convertible into shares at all (as of 2001). Investors must first convert into 'Entitlement Certificates', which are then convertible into the underlying shares only on set dates throughout the year (four times a year is usual).

In other markets, such as the Philippines, there is a delay (up to one month) between lodging bonds for conversion and receiving shares. Even this impediment would not cause bonds to trade at a discount if sufficient stock borrow were available. Investors in Ahold 4% 2005 EUR in the above scenario would simply buy the bond for 138, sell short 100% of the conversion property and lodge the bonds for conversion. Even though there is a time delay in receiving shares the investor is protected through his short position.

In many developing convertible markets, however, stock borrow is either inadequate or non-existent, and investors facing lengthy conversion procedures are exposed to adverse movements in the share price with no means of hedging themselves. This can result in a bond trading at a slight discount. Alert readers will realise that for a natural holder of the underlying shares, a 'discount' convertible does indeed represent a free lunch!

In other situations, lack of liquidity in the underlying shares can give the appearance of a discount when none really exists. Investors need to be aware of the time and size of price quotations.

In reality, however, discounts are very rare in the developed markets except where a callable convertible trades at 'net' parity (parity-accrued interest) to reflect the loss of accrued upon conversion. A full explanation of this so called 'screw clause' appears in Section 8.

3. Convertibles for Fixed Income Investors

Convertibles can boost fixed income performance by recreating straight corporate bond positions with additional exposure to rising equity markets. Specifically, fixed income investors can buy 'out of the money' convertibles trading with yields very close to, or even at, their straight bond equivalent. Convertibles have the added attraction of containing a long dated call option on the underlying stock, and will improve fixed income performance, if used appropriately.

After the huge market declines of 2001, there is now (October 2001) an unprecedented opportunity for fixed income investors to buy convertibles trading flat on their bond floors. Indeed, in Europe in October 2001, we estimated that 74% of the convertibles market was within 5% of its bond floor. We believe the opportunity for fixed income investors to enter the convertibles market has *never* been so attractive.[3]

There are three front line strategies which allow fixed income investors to use convertibles successfully:

1. Buy Convertibles as Straight Corporate Bond Alternatives

   Fixed income funds can buy convertibles trading close to (or even below) their bond floor (when the convertible's yield is comparable to pari passu straights). If the shares into which the bond is convertible rally, the bond will outperform equivalent straight bonds (explained below).

2. Buy Asset Swapped Convertible Paper

   Fixed income funds can also buy 'asset swapped' convertible paper. The transaction typically sees them entering into a swap agreement with a bank, passing the fixed payments from the convertible to the bank in return for LIBOR-linked floating payments. The yield is enhanced because fixed income buyers of asset swapped paper allow convertible arbitrage funds to retain the optionality. Fixed income fund buying of 'asset swapped' convertible paper has increased a great deal in recent years, and we will examine the mechanics of an asset swap transaction involving convertibles in Chapter 4.

3. Write Credit Default Swaps against Convertibles

   The newest area for fixed income funds to take advantage of convertibles is by writing Credit Default Swaps referencing convertibles as the default obligation. CDSs are explained fully in Chapter 4, but they are basically an insurance policy that pays par in the event of a default, in return for an agreed periodic fee. They are becoming popular with high yield fixed income funds because they are tradeable instruments in which the writer of the protection retains the credit upside (unlike an asset swap transaction).

   Fixed income investors can assess the attractiveness of a convertible very easily. Returning to the example of the Dutch Ahold 4% 2005 EUR convertible bond, we assume that Ahold stock has fallen to EUR 20 and that the convertible is trading at 93 (at a 1.19% 'risk' premium to its bond floor of 91.91). This means that fixed income investors can switch into the convertible for a premium of 1.09 points (assuming they hold straight bonds of similar profile).

   In yield terms, the convertible's YTM of 6.161% is only 36 bps below the 6.518% YTM on the equivalent straight debt.

   The precise value of the embedded call in the convertible can be calculated using a binomial tree model (see Chapter 6). But the simpler point is that if the yield 'give

[3] We have even noticed instances, at times of heavy convertible credit hedging, when the convertible offers a yield *pick-up* over pari passu straights (i.e. fixed income investors are actually paid to take an equity option!).

up' is very low, it ought to be attractive to move a straight bond position into the convertible alternative, if the equity environment looks favourable.

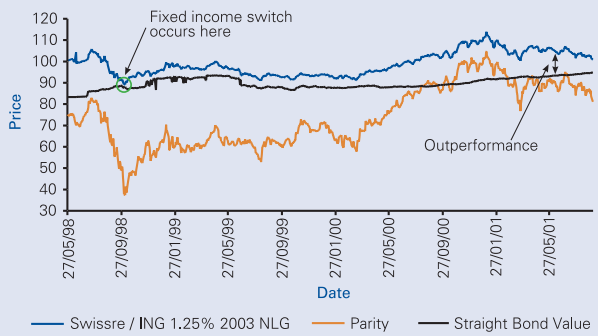
Convertibles as Straight Corporate Alternatives

Considerable interest in convertibles as fixed income portfolio diversification instruments has been notable in Europe and the US from 1998/9 onwards. This interest has been sparked by theoretical analysis that shows that, at least in reasonable equity markets or over the longer term, adding convertibles to a fixed income portfolio can have the effect of increasing returns *and* lowering volatility.

The theory is simple. Convertibles contain an embedded call option on the stock, and therefore will outperform straight corporate bonds in a rising equity market.

This is clearly indicated in Figure 10, where the rising share price of Dutch bancassurance company ING leads to a huge outperformance of the exchangeable Swiss Re / ING 1.25% 2003 NLG exchangeable bond over the equivalent Swiss Re straight bonds.

Fig 10: Swiss Re / ING 1.25% 2003 NLG



Source: Deutsche Bank Convertible Research

Table 4: Swiss Re / ING 1.25% 2003 NLG - exchangeable outperforms straight bonds

	Swiss Re / ING 1.25% 2003 NLG	Straight Bond Value
5 Oct 1998	89.25	87.93
1 Sept 2001	100.88	94.81
Income Adj. Return	13.0%	7.8%

Source: Deutsche Bank Estimates

By switching from the straight bond to the exchangeable, a fixed income investor would have enjoyed a very significant outperformance over holders of straight Swiss Re bonds.

But the case for a certain weighting in convertibles as an asset class at all times is more subtle, and is based on the negative correlation between bonds and equities.

This negative correlation between bonds and equities is easy to demonstrate:

Table 5: Negative Correlation between Bonds and Equities

Correlation	S&P 500 versus US Treasury 10 year	DAX / 10 Year Bund
1991 - 2001	-0.603	-0.783

Source: Deutsche Bank Estimates

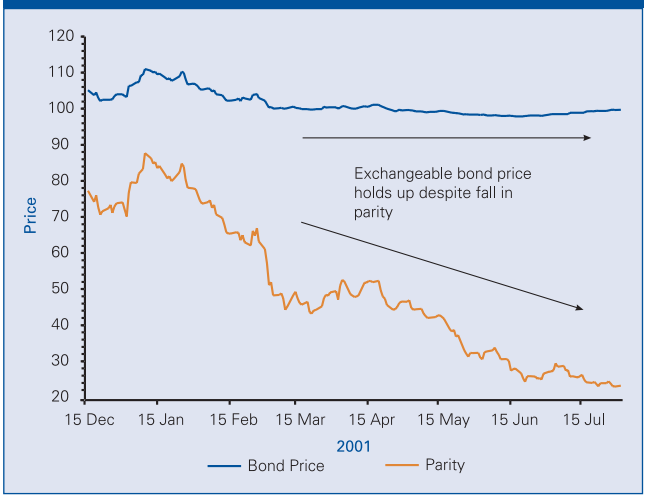
But what does this mean for convertible investors?

The secret strength of convertibles is that the negative correlation between bonds and equities means that convertibles will produce their performance enhancement exactly when the fixed income investor needs it: when equity prices are falling, bond prices will rise, and vice versa.

Before we go on to demonstrate this with statistics, it is important to note that the argument only works if the bond and underlying equity component of the convertible or exchangeable are not excessively positively correlated. The bonds that are most suitable for fixed income substitution are:

1. Exchangeable Bonds (where the issuer / guarantor and underlying stock are different companies). Stock price weakness should not affect perceptions of the credit of the guarantor, as we see with Bell Atlantic (Verizon) exchangeable into Cable and Wireless / NTL in Figure 11.

Fig 11: Bell / C&W - NTL 4.25% 2005 USD

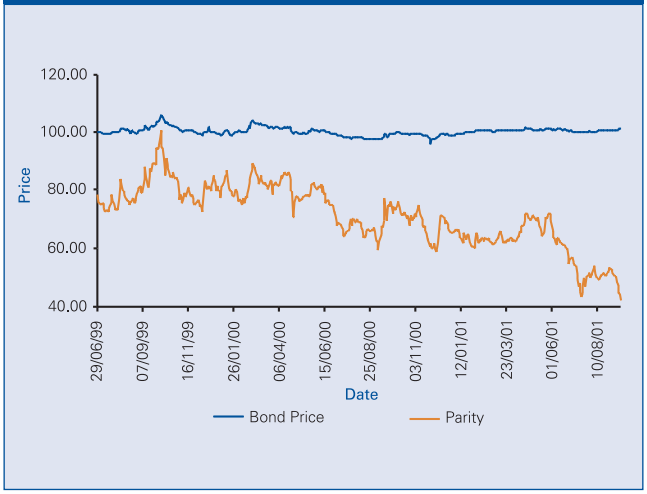


Source: Deutsche Bank Convertible Research

2. High Credit Quality Bonds. Generally, higher quality issuers will not suffer credit spread expansion even if the share price declines substantially (Figure 12 shows National Bank of Greece 2% 2003 EUR).

However, sub-investment grade issues may exhibit a positive correlation between stock and bond price, and are therefore not suitable for inclusion in a general fixed income fund. NTL 6.75 2008 USD sees the bond price tracking the share price downwards in Figure 13. These bonds may be

Fig 12: National Bank of Greece 2% 2003 EUR



Source: Deutsche Bank Convertible Research

Fig 13: NTL 6.75% 2008 USD

Source: Deutsche Bank Convertible Research

attractive for high yield investors, but are not suitable for fixed income substitution.

Having established which bonds are suitable for inclusion in a fixed income fund, we can look at the effect of adding convertibles to a portfolio of fixed income instruments in a reasonable equity market. If we go back to a period of reasonable equity returns (1997/1998), we can see the performance enhancing characteristics of convertibles very clearly.

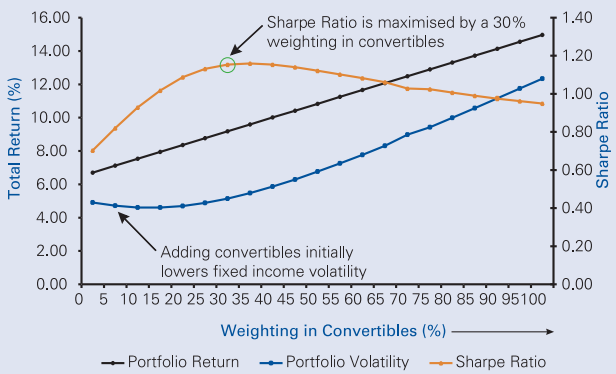
An analysis of this period shows that, beyond the obvious point that convertibles will outperform straight bonds if the underlying stocks go up, the negative correlation between the two asset classes (bonds and equities) causes a significant initial improvement in the Sharpe Ratio (defined below) of the fixed income portfolio as convertibles are added to it.

To demonstrate this effect, we added weightings in a balanced global convertible portfolio to the JP Morgan Global Bond Index and calculated the returns and volatility for progressively greater weightings in convertibles over the time period (Figure 14).

Because the period studied covered a bullish equity environment, the absolute return goes up with a greater weighting in convertibles. No surprise there. But what we find much more interesting is that the negative correlation between bonds and stocks causes the volatility of the mixed portfolio to fall as convertibles are added (up to a weighting of around 15%).

When this is plotted in terms of Sharpe Ratio (the amount of return above the risk free rate per unit of volatility), it becomes clear just how beneficial a certain percentage weighting in convertibles can have on a fixed income fund in a positive equity market.

Fig 14: Adding Convertibles Lowers Volatility and Increases Returns



Source: Deutsche Bank Estimates

But fixed income investors are certainly not restricted to simply buying and holding convertibles in a mixed portfolio. They can also buy Asset Swapped convertible paper or write Credit Default Swaps against convertibles. These two strategies are the subject of the next chapter.

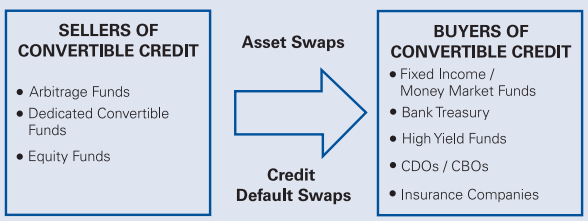
4. Credit Protection for Convertibles (Asset Swaps and Credit Default Swaps)

In this chapter we look at how convertibles can be bifurcated into a credit and an equity component through the use of Asset Swaps and Credit Default Swaps.

Stripping the credit (or bond) part of a convertible from the equity option enables the credit risk to be held by investors who understand credit, but who have no knowledge of (or interest in) equity volatility.

In fact, many of the fixed income investors who buy convertible credit are prohibited from owning any equity-related exposure at all, and so products that give them exposure to the fixed income component of the convertible without the equity risk are very attractive. Credit protection products allow convertible investors to concentrate on the equity component of the security, although if the credit moves in their favour, they may also be able to realise positive P/L by recalling the bonds and re-swapping them.

Fig 15: Who Buys and Sells Convertible Credit ?



Source: Deutsche Bank Estimates

We will look first at Asset Swaps, before turning to the newer market for convertible Credit Default Swaps.

Convertible Asset Swaps

The market in convertible asset swapping has grown dramatically since the mid 1990s. As of the middle of 2001, it is generally believed that at least 30% of the European convertible universe had been asset swapped, with this figure rising even higher in Japan. Even in the US, a market whose credit quality previously precluded extensive asset swapping, the emergence of the investment grade CoCo/CoPay issuer (see Chapter 10) has brought a sizeable pick-up in the level of asset swapping in this market too.

The spreads on convertible asset swaps will always be higher than on comparable straight bonds because of their callability (discussed below). The higher spread can make swapped convertible paper attractive to fixed income buyers, as can the fact that convertible asset swaps open up a whole new universe in corporate credit. There are many examples in Europe and the US where a convertible issuer has no publicly traded straight debt outstanding, and the convertible often represents the only vehicle for credit investment available to a fixed income buyer.

For the convertible investor, the use of asset swaps has transformed the convertibles market. It has led to much larger issue sizes (in Europe and the US particularly) and has enabled convertible investors to focus on what they really understand, which is either the underlying equity (in the case of outright convertible funds) or equity volatility (in the case of hedge funds).

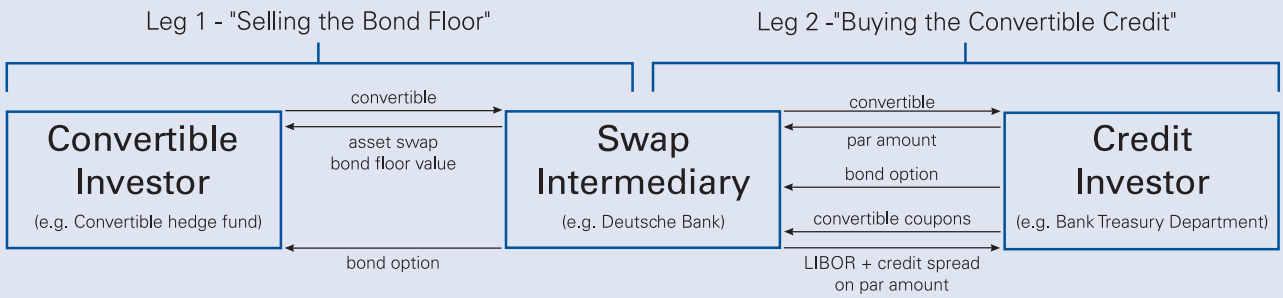
So how do convertible asset swaps work?

The Classic Par / Par Asset Swap

The majority of asset swaps are now conducted as Par / Par swaps. We will examine the mechanics of the classic Par / Par swap and then discuss exceptions to this standard model below.

Three players are generally involved in the full asset swap

Fig 16: Full Asset Swap Transaction



Source: Deutsche Bank Estimates

transaction (which is shown in Figure 16):

1. Convertible Investor - who sells the bond floor of the convertible to remove credit risk and free up balance sheet.

2. Credit Investor - who takes on the convertible credit risk for an attractive spread.

3. Swap Intermediary - who facilitates the transaction. The intermediary is usually an investment bank.

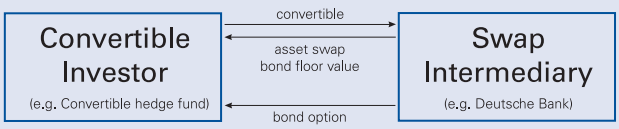
The flows in the overall transaction are shown in Figure 16. We will split them into two legs: Leg 1 - between the convertible investor and the swap intermediary, and Leg 2 - between the credit investor and swap intermediary.

The Convertible Investor

Leg 1 - Convertible Investor to Swap Intermediary - 'Selling the Bond Floor'

We turn first to the 'swap' between the convertible investor and the swap intermediary, which we isolate in Figure 17.

Fig 17: Leg 1 - 'Selling the Bond Floor'



Source: Deutsche Bank Estimates

The first point to understand about this transaction is that it is not a physical interest rate swap. After the initial exchange, in which the convertible investor sells the actual convertible to the swap intermediary for the (asset swap) bond floor, (retaining also the right to recall the bonds) no other cash flows are exchanged. However, asset swap methodology is used to calculate the price of the asset swap bond floor, and this is why it is crucial to understand asset swap conventions.

The reason asset swap conventions are used to calculate the bond floor in a convertible asset swap is that, even though no actual asset swap cash flow payments are exchanged in Leg 1, they *will* be exchanged between the

swap intermediary and the end credit investor in the second leg of the transaction. To avoid a mismatch of payments, asset swap conventions are used on both legs.

Determining an 'Asset Swap' Bond Floor

As stated above, an asset swap bond floor is calculated to determine how much is paid to the convertible investor in return for selling the bonds to the swap intermediary.

The asset swap bond floor in a Par / Par swap is:

PV of an interest rate swap where LIBOR + credit spread payments are exchanged for the convertible coupons

(remember that this 'swap' is notional only - no exchange of coupons and LIBOR + credit swap payments actually occurs on Leg 1).

This notional swap is valued using asset swap conventions and is not simply the PV of the convertible cash flows discounted using a credit spread. The asset swap bond floor is *not* the same at the traditional convertible bond floor, and is *not* calculated in the same way as yield to maturity. In our view, this is very important.

Asset Swap Bond Floor ≠ Traditional Bond Floor

To show how an asset swap bond floor is calculated, we will use an example:

ABC 5% 2006 USD

Swap Settlement Date	24 September 2001
Maturity Date (convertible)	24 September 2006
Coupon Pay Dates (annual)	24 September annually
Redemption	100%
Credit Spread	100 bps
Swap Frequency	Quarterly
Bond Day-count	actual / 360
Convertible Price	102.00

What happens in Table 6 is fairly straightforward. But before we can look at the swap notional payment amounts (columns A & B), we need to know how to calculate implied LIBOR (column D), because this is the rate we will use to determine the amounts of the floating leg payments.

Calculating Implied LIBOR:

To calculate implied LIBOR, the relevant zero coupon yield curve is boot strapped from the offered side of the swap curve. We need a zero coupon curve in order to find the discount factors that we will use to calculate implied LIBOR. As the above swap is being calculated on a quarterly basis, we have four legs a year on the floating side, and therefore need 20 3M zero coupon points (for a five year bond).

From the zero curve, we calculate discount factors using:

$$1/(1 + \text{zero coupon rate} / 100)^{\text{number of days / 360}}$$

From these discount factors (some of which appear in column C) we get the implied LIBOR by applying:[4]

$$((DF_{T-1} / DF_T) - 1) \times 36000 / \text{number of days}$$

Therefore to calculate implied LIBOR for 24 September 2006 we have

$$\frac{0.798079682}{0.785539738} - 1 \times (36{,}000 / 92) = 6.25\%$$

[4] Note: You cannot calculate the exact implied LIBOR in column D for all the points from the DFs in column C as we use many more zero coupon points in actual calculation of implied LIBOR.

Table 6: Calculating the Asset Swap Bond Floor of ABC 5% 2006 USD

Date (T)	Column A **Fixed Income Flows (USD)**	Column B **LIBOR Floating Flows (USD)**	Column C **Zero Coupon Curve Discount Factors**	Column D **Implied LIBOR (%)**	Column E **NPV**
24 Sep 01	10,000,000.00	-10,000,000.00	1		0.00
24 Dec 01		89,315.01	0.993464241	2.53	88,731.27
24 Mar 02		90,012.97	0.987047154	2.60	88,847.04
24 Jun 02		96,580.46	0.980086102	2.78	94,657.16
24 Sep 02	-500,000.00	99,735.36	0.972869376	2.90	-389,405.21
24 Dec 02		122,149.12	0.963535478	3.83	117,695.01
24 Mar 03		125,747.49	0.953924924	4.03	119,953.67
24 Jun 03		139,318.81	0.943194832	4.45	131,404.78
24 Sep 03	-500,000.00	148,863.67	0.93170614	4.83	-327,155.88
24 Dec 03		146,316.43	0.92056376	4.79	134,693.60
24 Mar 04		153,724.48	0.908889375	5.08	139,718.55
24 Jun 04		163,934.78	0.896483901	5.41	146,964.89
24 Sep 04	-500,000.00	170,906.83	0.88364008	5.69	-290,799.92
24 Dec 04		161,501.90	0.871764543	5.39	140,791.63
24 Mar 05		163,676.82	0.859840548	5.55	140,735.97
24 Jun 05		174,418.80	0.847228431	5.83	147,772.57
24 Sep 05	-500,000.00	180,087.32	0.8343353	6.05	-266,914.44
24 Dec 05		170,875.03	0.822361936	5.76	140,521.12
24 Mar 06		170,839.07	0.810541081	5.83	138,472.08
24 Jun 06		181,697.84	0.798079682	6.11	145,009.35
24 Sep 06	-10,500,000.00	10,185,193.31	0.785539738	6.25	-247,295.52
				NPV	**394,397.75**
				Notional	**10,000,000.00**
				Net Bond Floor	**9,605,602.25**
				Asset Swap Bond Floor =	**96.056**

Source: Deutsche Bank Estimates

Column D shows the implied LIBOR points. We then add the spread (100 bps) to the implied LIBOR rate and apply that to the principal (USD 10 million) to calculate the floating leg payments:

Notional x (implied LIBOR + credit spread) x (number of days / 360)

In the example in Table 6, we have rounded the implied LIBOR rates, but in order to calculate the exact floating payment amount on 24 December 2001 the equation is:

USD (10,000,000 x 0.03533341) x (91 / 360) = EUR 89,315.01

This amount is then discounted using the zero coupon curve discount factor (column C) to find its present value:

(USD 89,315.01 x 0.993464241) = EUR 88,731.27

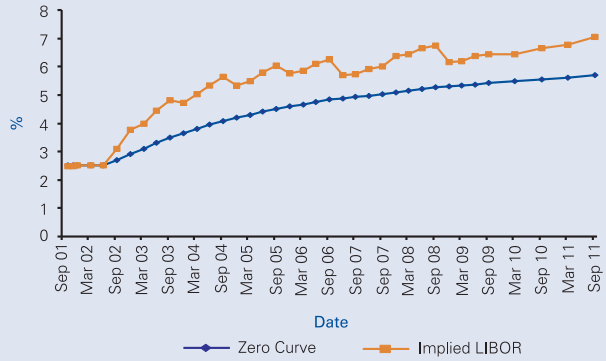
We then build up our twenty floating legs (together with the exchange of principal) as in column B. The fixed flows are known in advance and are entered in column A. All the flows on both sides of the swap are then PV'd using the original zero coupon discount rates (column C) and then simply summed to get the asset swap bond floor.

This asset swap bond floor is the amount the convertible investor will be paid in exchange for the convertible at the time of the swap.

Note on the Implied LIBOR Curve

The implied LIBOR curve is well above the zero coupon curve, as is demonstrated in Figure 18. The large difference between the two curves is one of the reasons why the asset swap bond floor is different from the traditional bond value.

Fig 18: Zero Coupon Curve and Implied LIBOR Curve



Source: Reuters

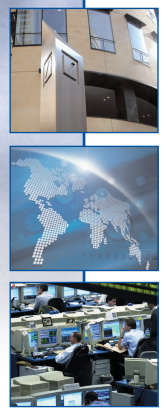
What does the Convertible Investor Own?

Physical ownership of the bonds passes from the convertible investor to the swap intermediary (and then probably on to the credit investor), at the time of the 'swap'.

But the convertible investor retains the right to call the bonds back at any time (subject to conditions explained below) at the recall spread. This gives the convertible investor an option on both the underlying stock and the credit spread of the issuer. The recall spread is agreed at the time of the initial swap. The recall spread will always be tighter than the original swap spread (i.e. a higher price). The asset swap will therefore usually be quoted LIBOR + 100 to LIBOR + 90 bps, with 100 bps the bid and 90 bps the recall spread.

Why Exercise the Option to Recall the Swap?

There are four reasons why the convertible investor might call the bonds back, either at maturity or before:



1. To Convert the Bonds - If the convertible is 'in the money' at maturity, the bonds will be recalled so the convertible investor can convert them.

2. If the Spread has Tightened - If the spread tightens significantly it may be profitable for the convertible investor to recall the existing swap and re-swap the bonds at a higher bond floor.

3. Corporate Action - It may occasionally be necessary to recall the bonds to participate in some kind of corporate action.

4. To Sell the Convertible - If the convertible investor wants to sell the convertible for any reason, they must first recall the bonds.

The amount that the convertible investor must pay to recall the bonds is calculated using exactly the same methodology as was used to calculate the original asset swap bond floor. The only differences are:

1. The Recall Spread is the spread used.

2. The date for calculating the recall bond floor will be the day of the recall, with the current swap curve being applied.

3. The bid side of the swap curve will be used - as opposed to the ask side which is used to calculate the original bond floor when the swap is first calculated.

Other Recall Scenarios:

The right to recall the bonds is held by the convertible investor and is generally only exercised when it is in the convertible investor's favour. However, a couple of extra points need to be made.

1. Auto Exercise - If the issuer calls the convertible, normal procedure would see the swap intermediary call the bonds back from the credit investor on behalf of the convertible investor, on the basis that the convertible investor will want to convert them (if in the money).

2. Contingent Mandatory Exchange (the so-called 'Death Spiral') - Many issues in the US (and a few in Europe) allow the issuer to redeem the convertible in shares rather than cash. This can have many unfortunate consequences, and one of them is that the credit investor is usually unable to take delivery of physical shares on redemption. In this instance, normal procedure is for the swap intermediary to have the right to sell the shares delivered in lieu of cash back to the convertible investor in return for the redemption amount in cash.

3. Event of Default - In the event of default, the convertible investor usually has a limited time period (often 5 days) to decide whether or not to call the bonds. It is hard to foresee a situation in which this call would be exercised, and so the objective is to give the credit investor the maximum amount of time to enter into negotiations with the issuer about recovery, restructuring and administration.

Recall Penalties

Unwinding the swap early often causes problems for the end buyer of the credit. The credit investor will usually have set up liabilities of its own to match the inflow of floating payments, and so will face significant disruption if it is forced to unravel these transactions early.

In order to compensate for this, small penalties are usually payable in the event of early recall.

'Make Whole' Provisions - The most common remedy is the 'make whole' payment, which is usually a payment of the

PV of the spread that would have been payable on the swap for the specified 'make whole' period - usually six months. This should give the credit investor time to untangle its own obligations and replace the lost swap with another one.

Occasionally the 'make whole' penalty is an absolute amount (e.g. 0.5 - 1.0 point). Absolute amount make wholes are widely used in Asia. In the high yield market, this amount is usually punitive (perhaps 5 points), meaning that convertible investors entering into these swaps are effectively locked in until maturity.

In very rare instances there can be a restrictive non-call period, but this is not common due to the necessity of bonds being recalled to participate in unforeseen corporate actions.

Variations on the Par / Par Theme

Although the Par / Par structure is now the established standard for convertible asset swapping, there are other methodologies:

Premium Redemption

Many bonds in Europe are issued at par (100%) but redeem at a premium (say 125%).

These bonds are easily handled by treating the difference between par (or more correctly par + final coupon) and the redemption amount as a balloon final coupon.

OID (Original Issue Discount)

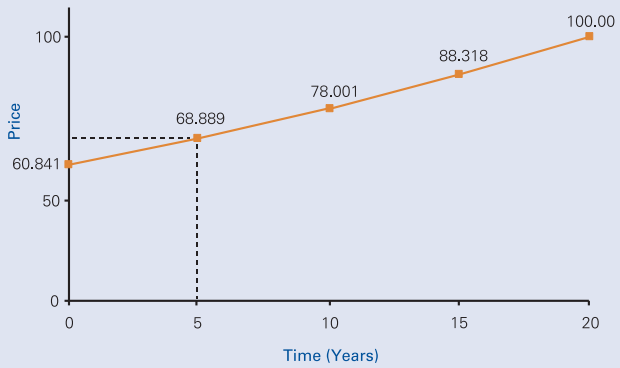
Many US convertibles in 2000 and 2001 were structured as deeply discounted 0% coupon bonds with 20 year maturities and rolling 5 year puts.

When asset swapping these bonds, there are two possible methodologies:

1. Swap Using Issue Price as Notional - This method uses the issue price as the notional and uses the difference between the issue price and the first put as a balloon payment exactly as in the premium redemption case above. Swap intermediaries tend to avoid this method as it results in considerable credit investor counterparty risk. This is because the balloon payment, that is the difference between the issue price and the first put price, is back end loaded and very high.

2. Swap to First Put Date - Swapping to the first put date means that the first put price is the notional amount. The credit investor will pay the full amount of the put up front and this lessens the counterparty risk significantly versus the issue price notional swap. This method is preferred by swap intermediaries.

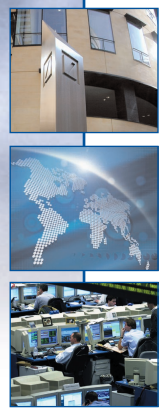
Fig 19: Discount Swaps: Verizon 0% 2021 USD



Method 1: 60.841 is notional, with 8.048 as balloon payment in year 5

Method 2: 68.889 is notional, with no other payment passing from credit investor to swap intermediary

Source: Deutsche Bank Estimates



Interestingly, the bond floors on the two methods will not be exactly the same, with the issue price swap generally giving a marginally higher asset swap bond floor. This is because the swap notional is smaller using just the issue price swap, and therefore the PV of the floating payments is lower so the PV of the swap is lower, resulting in a higher bond floor.

The two methods are illustrated in Figure 19, where we show two alternative methods for asset swapping Verizon 0% 2021 USD.

Why Asset Swap?

The majority of asset swap transactions involve convertible arbitrage funds. Why do they asset swap convertibles?

There are four main reasons:

1. Credit Protection. The hedge fund is no longer exposed to the credit of the issuer on the downside if the position is swapped. This is the primary reason for asset swapping.

2. Leverage. Once a position is swapped the hedge fund receives the value of the bond floor in cash. An 'out of the money' position such as ABC Corp 5% 2006 USD might be put on for only a few points (5.94 in this case). If the delta of the remaining 'stub' option is high enough, once the delta (hedge ratio x stock price) is sold, the hedge fund might receive a net cash credit to put on the trade! Asset swapping can also help with investor risk limits.

3. Cross Margining. The asset swap is recognised by more sophisticated prime brokers (e.g. Deutsche Bank), which enables cross margining of the bond option against the stock short.

4. Floating Strike Call Option. The sale of the bond floor isolates the equity call option with a floating strike (struck at the recall spread) on the underlying shares. The implied volatility of this option can be calculated, and whether or not it is attractive versus comparable options and the volatility of underlying stock, will be key in determining whether the trade is put on.

The Credit Investor

Leg 2 - Credit Investor to Swap Intermediary - 'Buying the Convertible Credit'

Having examined the rationale and methodology behind the convertible investor's sale of the credit, we now turn to the position of the end buyer of the credit (the credit investor).

It is important to stress that the sale of the convertible credit to the credit investor *is* a full interest rate asset swap, involving a full schedule of cash flow exchanges.

As Figure 20 reminds us, in the classic Par / Par swap the credit investor:

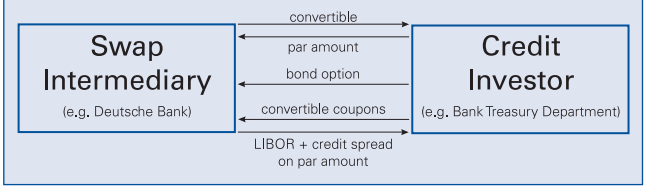
1. Buys the convertible for par;

2. Passes the coupons on the convertible to the swap intermediary; and

3. Receives LIBOR + credit spread on the full par amount based on the frequency of the contract (but usually quarterly referenced to 3M LIBOR).

It is important to understand that the credit investor receives LIBOR + credit spread on the full par amount of the bonds, in exchange for assuming the full credit risk of the convertible. This is because the credit investor physically owns the bonds, and will only receive whatever is paid on the bonds at maturity (recovery rate in the event of default).

Fig 20: Leg 2 - ' Buying the Convertible Credit'



Source: Deutsche Bank Estimates

It is important also to note that the swap with the credit investor is callable by the swap intermediary, to mirror the call the convertible investor has. If the swap is called early the credit investor will simply receive the par amount back early, plus whatever early redemption penalties were agreed.

It is also a feature of Leg 2, between the credit investor and the swap intermediary, that it is not contingent on Leg 1 in any way. This means that in the event of default, or any other event, the credit investor will still be required to honour the swap payments - paying the fixed coupons based on the convertible and receiving floating as per the original agreement.

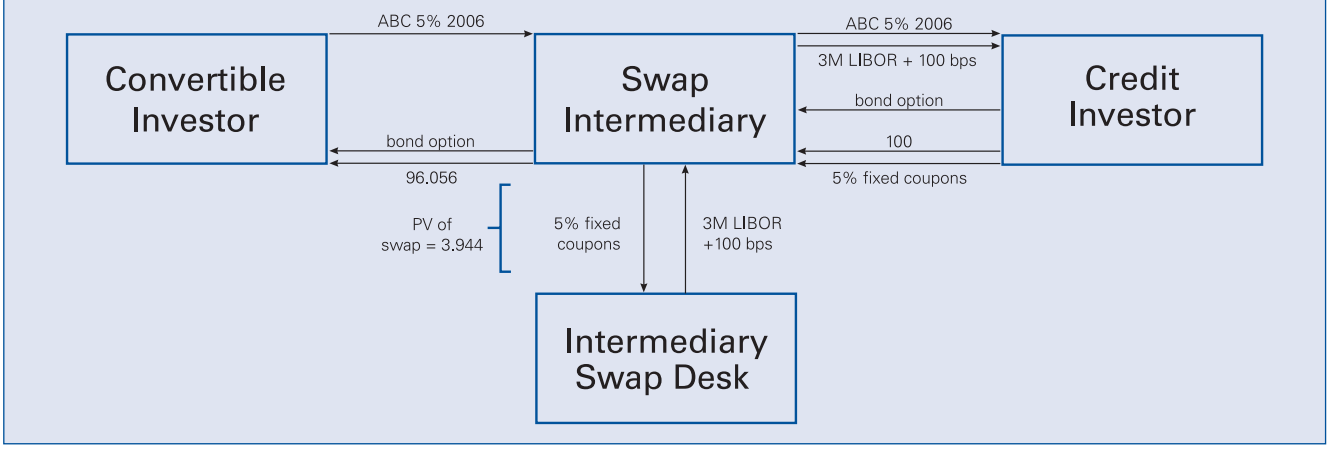
It is usual for the credit investor to physically own the bonds during the life of the swap, but the bonds might be placed in an SPV (Special Purpose Vehicle) if specific counterparty risks are identified, or if the credit investor is precluded from holding convertible instruments.

Based on our example of ABC Corp 5% 2006 USD above, it appears that 3.944 points have 'gone missing' in the transaction. The swap intermediary has paid the bond floor of 96.056 to the convertible investor but has received 100 from the credit investor.

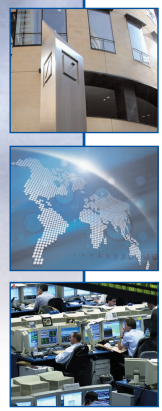
So what happened to the missing 3.944 points?

Figure 21 demonstrates that 3.944 is exactly the PV of the swap that the swap intermediary must conduct internally with its own swap desk in order to convert the fixed income flows from the convertible into the LIBOR + credit spread payments on the full par amount to give to the credit investor.

Fig 21: ABC 5% 2006 USD - Fully Asset Swapped



Source: Deutsche Bank Estimates



Other Variations

Fixed / Fixed Swaps

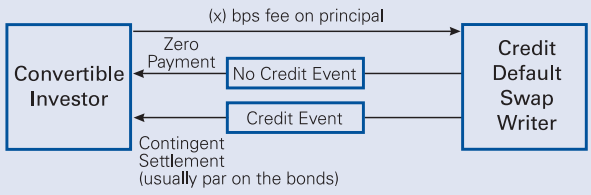
In Japan, where the credit buying community is more accustomed to receiving fixed interest rather than floating LIBOR, most asset swaps are done as fixed / fixed transactions. There is no material difference with the floating swap described above, except that the credit investor passes the fixed coupons from the convertible and receives fixed payments as determined by a pre-agreed schedule.

Credit Default Swaps (CDS)

A credit default swap is very similar to an insurance policy. A holder of a security, a loan, or any other debt obligation pays a fixed premium (usually annual) to 'insure' the risk of the obligation not being fulfiled.

Credit Default Swaps transfer the credit risk of a corporate from the buyer of the swap to the seller, and as such allow investors to short the credit of an issuer. Two parties enter into a swap agreement where the protection buyer pays a fixed periodic payment, usually expressed in basis points per annum on the notional amount, for the life of the agreement. The protection seller (the credit investor) makes no payments unless a specified credit event occurs, in which case the protection seller is obligated to make a contingent settlement (i.e. to compensate the convertible investor for the credit event).

Fig 22: A Credit Default Swap



Source: Deutsche Bank Estimates

The rise of CDSs has given investors a new alternative to asset swaps for hedging the default risk of an issuer.

Credit events are determined by the 1999 ISDA Credit Derivative definitions. Investors are given full protection against:

1. **Failure-to-Pay;**
2. **Bankruptcy;**
3. **Obligation Acceleration/Obligation Default;**
4. **Repudiation / Moratorium; and**
5. **Restructuring***

*(can be ISDA 1999 full restructuring events or 'Modified Restructuring').

Credit default swaps provide an efficient hedge for longer-term credit risk (credits of over one year to maturity). The credit spread is locked in for the term of the swap, with the credit seller (convertible investor) retaining exposure to changes in interest rates. Maturities can be customized to suit convertible bond idiosyncrasies, reflecting put and / or call dates if necessary.

From the perspective of the CDS seller (credit investor), the credit default swap provides a synthetic long bond position giving a fixed return for the term of the default swap (in excess of that which would be available from buying the bond directly). CDS writers can also gain exposure to specific credits in sizes and maturities not always available in the corporate bond market.

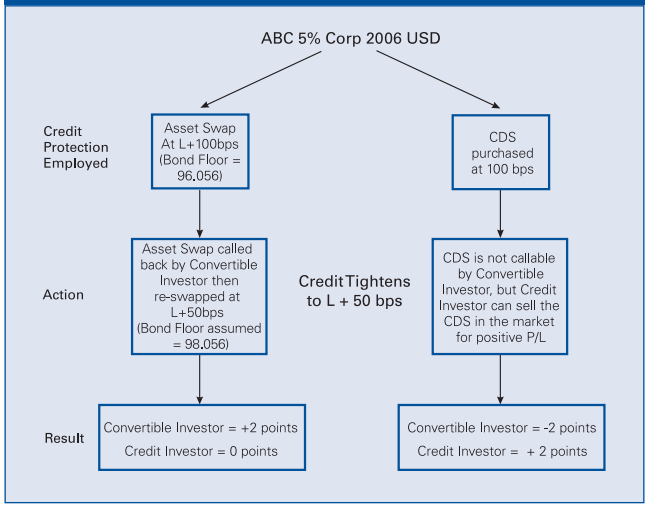
The wider CDS market is highly liquid and currently (2001) accounts for over 50% of the total credit derivatives market. The market has grown with phenomenal speed. Starting

from just USD 50 billion in 1996, the market had increased to USD 350 billion by 1998. The USD 1 trillion mark was reached in 2000.

With more and more players and solid demand from both sides of the market, the bid to offer spread for high-grade corporate names can be as low as 10 bps or less for maturities between one and five years (in normal market conditions). The normal range for maturities is one to ten years, and the market for investment grade names tends to be very liquid, with transaction sizes ranging from USD 5 million - USD 10 million, but occasionally up to USD 500 million for portfolio trades. Contract transfer and assignability has been greatly enhanced by the introduction of standardised documentation and terms by ISDA (Deutsche Bank's ISDA documentation is available on www.dbconvertibles.com).

The key difference between CDSs and asset swaps, is that the writer of the CDS retains the credit upside. This means that CDSs will usually provide protection at a lower rate than an asset swap (in which the credit investor actually sells the credit tightening option through the callability of the asset swap).

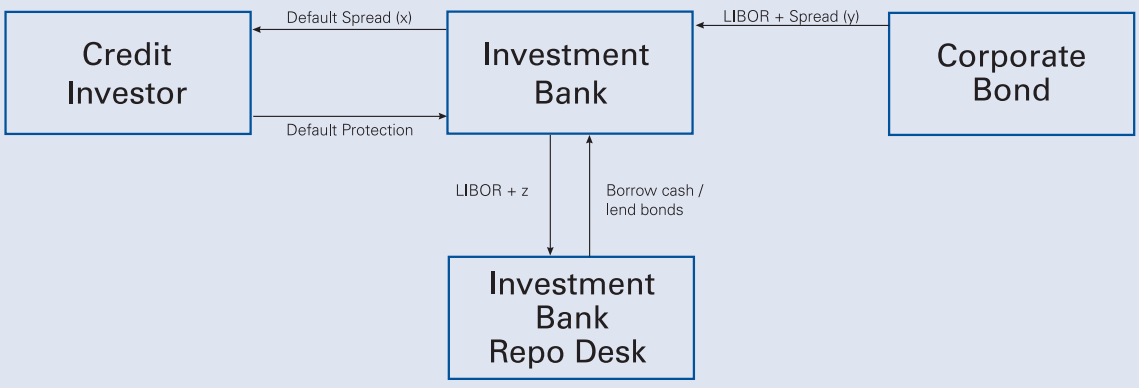
Fig 23: CDS Gives Credit Tightening Upside to CDS Writer



Source: Deutsche Bank Estimates

The pay-off profile is completely different in a CDS, as compared to an asset swap. Figure 23 illustrates that the CDS writer will make a positive capital gain if the spread tightens, whereas the buyer of asset swapped convertible paper (also a credit investor) does not benefit from a spread tightening.

Figure 24: Credit Default Swaps - The Mechanics



Source: Deutsche Bank Estimates

How are CDSs priced?

Although CDS spreads have a strong correlation to spreads in the cash markets, they are tradeable securities in their own right and subject to unique supply and demand factors. The 'basis' between corporate bonds and CDS spreads is influenced by a number of factors, including mismatches in documentation, although the repo costs of the underlying securities is probably the most significant influence on any apparent arbitrage.

Arbitrage Approach to Pricing a CDS

The repo rate is central to the bond / credit default swap arbitrage. This is best illustrated by looking at a sample trade: an investor buys default protection, paying x basis points per annum. This is used to hedge bonds which earn LIBOR + y basis points. The bonds are financed at LIBOR + z basis points. For 'arbitrage-free' pricing the rate earned on the bonds should exactly equal the insurance cost plus the cost of financing (i.e. x = y - z). Consequently the CDS spread should approximate to the spread over LIBOR minus the repo spread. This is more easily explained diagrammatically (see Figure 24).

The potential for arbitrage means that the mark to market for CDSs should be closely related to changes in the credit spread of the issuer in the corporate bond market. Thus CDSs should hedge specific changes in the credit spread of the issuer, as well as the outright risk of default, though this can be limited by liquidity in the repo market.

Unwinding Credit Default Swaps

CDSs allow investors to short bonds synthetically. CDSs are not 'callable' by either side, and so there is no optionality. Consequently, if a convertible investor wants to break a CDS early they will have to 'buy' the credit back from the credit investor, and the price may well have moved from the original level. But how is the 'value' of a CDS determined? Because swaps are priced in terms of spreads over LIBOR, the 'price' (which may be a positive or negative for the convertible investor) is actually the net present value of the difference between the initial spread and the spread at the time of closing the swap.

We have approached the pricing of a CDS using the 'no arbitrage' method above (deriving the correct CDS level from the difference between current credit spreads and financing costs). But there is another, more predictive, method to pricing. This second approach grew from option pricing, and treats the default swap as a credit option.[5]

The predictive model requires both probabilities of default and the most likely loss in the event of default. The rate of recovery (i.e. the percentage recovery value per 100 of exposure) may be observed from historical data for different industry sectors and ratings.

If we make the assumption that existing credit spreads in the cash market contain all known information about the likelihood of default, then probability of default is:

Probability of Default = Spread / (1 - Recovery Rate / 100)

This is a crude yet reasonably accurate approximation of the probability of default.

But the credit curve will have a term structure, requiring different values at different time intervals. Where gaps exist

[5] Academics have constructed an option pricing model for default swap pricing. But although the CDS transaction does involve the payment of a fee in return for a payoff should a default occur, CDSs should not be confused with genuine default options. The key characteristic of options is their asymmetrical payoff and price performance as the price (or credit spread) of the underlying obligation changes. With CDSs, by contrast, the price varies directly with changes in the credit spread of the underlying, in much the same way as the price of an interest rate swap.

in the observable maturity spectrum, assumptions have to be made. In an ideal world, there would be a complete set of zero coupon bonds across every maturity, for every corporate name, from which to extract the default probabilities. But unfortunately the world is not that simple! So in practice the credit curve is built up from a matrix of observable bonds and existing CDS contracts.

When calculating the present value of a default swap, the discount factors are derived from the credit curve, (in the same way as they are derived from the zero curve in the swap market).

The above is a very brief summary of a much more complex subject, but it gives the basic outline of how the present value of a CDS is calculated.

The main differences between CDSs and asset swaps

To summarise, there are two main differences between asset swaps and CDSs. Investors who hedge a convertible via an asset swap receive an up front payment for the fixed income portion of the bond. This effectively gives the convertible investor off-balance sheet gearing. With CDSs this does not occur; the investor simply makes a periodic 'insurance' payment and there is no gearing benefit.

Secondly, asset swaps give optionality; the bond can be repurchased at the recall spread, giving the convertible investor upside in any improvement in the credit. CDSs create a synthetic short, and therefore result in full exposure to any changes in the credit spread. This means that they eliminate any exposure when used as a hedging instrument. CDSs give no protection against rate changes. These differences are reflected in the cost of the two instruments.

Table 7: Differences Between Asset Swaps and CDSs

Credit Default Swap	Asset Swap
Standard contracts	Non-standard contracts
Not callable	Callable
Hedges spread risk	Hedges spread and rate risk
No leverage	Leverage
Easier to assign	Difficult to assign
No fixed income optionality	Credit spread option struck at the recall spread
Lower spread over LIBOR	Higher spread over LIBOR

Source: Deutsche Bank

CDSs give credit buyer upside from spread improvement

For sub-investment grade bonds, CDSs may well prove more attractive than asset swaps from the credit investor's perspective. High yield investors, in particular, look as much for the capital gain as for actual income in realising their investment objectives. Under an asset swap, the convertible investor retains the option to recall the bonds, and therefore retains the upside from any credit improvement. This is clearly against the interests of the high yield investor. Consequently, with high yield asset swaps, credit buyers are seeking harsher and harsher penalties for early recall.

CDSs give the credit buyer the upside from any spread improvement, and so are more suitable for high yield funds as an investment vehicle. From the point of view of the convertible investor, giving up the credit upside is often a small price to pay for the ability to hedge more risky credits, which often have more interesting (and volatile) underlying equities.

5. Convertibles for Equity Investors

Studies of convertible performance have suggested that, over a long time period, convertibles can replicate virtually all of the upside performance of equities with substantially lower volatility.

For equity investors, convertibles offer the following three components:

Fig 25: Convertibles for an Equity Investor

Source: Deutsche Bank Estimates

We will deal with each of these three components in turn, and in doing so will explain how an equity investor can determine whether to switch an equity position into a convertible position.

1. Convertible holder still owns equity - The most important point to stress is that a convertible investor still controls the underlying shares. With most convertibles, conversion can occur at any time. The number of shares owned via a convertible is simply:

   Conversion Ratio x Number of Bonds

   Once again turning to the example of the Dutch food group Ahold 4% 2005 EUR, we will assume that Ahold stock is trading at EUR 36.65 and the convertible at 121.75.

   Equity Value = 31.0463 x EUR 36.65
   = 113.78 (EUR 1,137.80 per bond)

2. Put option on equity - The 'put option' on the underlying shares is the convertible's cash redemption at maturity. An equity investor buying Ahold 4% 2005 EUR for 121.75 when parity is 113.78 pays a small premium (7.00%) to own the same number of shares, but gains a lot of potential downside protection. If, at maturity, the shares have fallen from EUR 36.65 to EUR 18 (i.e. parity drops from 113.78 to 55.88), the bond will still be worth 100 (redemption value). The shares have fallen by 50.89% but the bond is only down 17.86% (even before the convertible's yield advantage is taken into account).

   The put value of the convertible can be roughly modelled using the Deutsche Bank Option Calculator (located on the www.dbconvertibles.com home page). An investor can model the put by setting up a European style option with parity as the equity spot price and 100 (or whatever the redemption value is) as the strike price.

   For our calculation we use 4.65% as the risk free rate and 27% for the volatility. For the dividend yield we used 1.5%, and maturity for Ahold 4% 2005 EUR is 19 May 2005. Valuing the put to maturity in 2005, we get:

   Put Value = EUR 10.20 (EUR 102.00 per bond)

   Obviously there is a degree of credit risk attached to the put (as with all puts). Therefore investors need to be more wary of lower credit quality convertibles in this respect.

3. Income Advantage - An equity investor switching out of

shares and into a convertible gives up equity dividends and receives convertible coupons. This is likely to enhance the current yield profile. In order to calculate the present value of the yield advantage it is necessary to project the stock dividends and coupons into the future. The difference between the cash received is then PV'd to calculate the value of the income advantage.

Table 8 below shows how this calculation is arrived at.

PV of Income Advantage = 7.77

The total economic value of the convertible to an equity investor is therefore:

Equity Value	**= 113.78**
+	
Put Value	**= 10.20**
+	
Income Swap	**= 7.77**
Total	**= 131.75 (per bond)**

This 131.75 total is well above the 121.75 theoretical value calculated using a binomial tree. Unfortunately, the equity investor has not discovered a free lunch here. The disparity is caused by the issuer's option to call the bond early and force conversion if it is 'in the money'. An early call will reduce the value of both the put and the income advantage. To value the bond properly, a binomial tree is used to account for the issuer's call option and to model its exact effect on the bond's theoretical value.

Breakeven Horizon

Discounted cash flow analysis also allows equity investors to work out what premium they should pay for a convertible in order to 'breakeven' by a certain time.

Table 8 shows how discounted income advantage can be used to calculate how long it takes to amortise different levels of premium. From Table 8 it should be clear that an investor paying EUR 59.60 per bond (premium of 4.95%) will 'breakeven' in exactly three years.

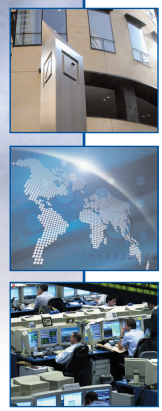
The ringed box shows that in 2004, the PV of the income

Table 8: Ahold 4% 2005 EUR - Value of Income Advantage over Shares

Year	Convertible Coupon (4% on EUR 1,000)	Stock Dividend (1.5% x EUR 1,217.50)	Yield Advantage	PV (4.65%)	Running Total
2002	EUR 40.00	EUR 18.26	EUR 21.74	EUR 20.78	EUR 20.78
2003	EUR 40.00	EUR 18.26	EUR 21.74	EUR 19.85	EUR 40.63
2004	EUR 40.00	EUR 18.26	EUR 21.74	EUR 18.97	EUR 59.60
2005	EUR 40.00	EUR 18.26	EUR 21.74	EUR 18.13	EUR 77.73
				Total Income Advantage per Bond =	**EUR 77.73**

We use dividend yield x market price of convertible (1.5% x EUR 1,217.50) for this table to calculate the opportunity cost of owning the same cash value of shares via the convertible.

Source: Deutsche Bank Estimates



advantage is EUR 59.60, giving a 3 year 'breakeven' to an equity investor switching into the convertible in 2001.

Equity Switching

Convertibles can be highly effective in equity portfolios when they form part of a 'switching' strategy. Investors 'switch' between the underlying shares and the convertible to protect profits and retain equity exposure in difficult market conditions. Equity investors switching into convertibles at low premiums often give themselves a highly asymmetric risk/return profile. If the shares continue to rally, the convertible will rise on virtually a 100% delta (i.e. 1 for 1) with the shares. If the shares fall, the convertible will outperform as premium expands on the way down. And all the time the convertible is likely to be yielding more than the underlying shares.

The main objection to using 'in the money' convertibles from equity fund managers is that they only buy stocks which they believe are going up, and therefore do not need the protection inherent in convertibles. This may be so for active managers (although the markets of 2000 and 2001 rather undermine this argument), but funds benchmarked against major indices will usually be compelled to retain exposure to certain large cap names even though they may have a cautious stance on the stock (Vodafone in 2001 is a good example). For index-related funds, convertible and exchangeable bonds can be liquid, inexpensive and obviously defensive alternatives to OTC put strategies.

We chose a benchmark US convertible, Seacor 5.375% 2006 USD, to demonstrate the 'switching' strategy in action (Figure 26).

The Switching Strategy in Action

When the convertible's premium is very low an equity investor sells the underlying shares and switches into the convertible. Because the convertible's premium is so low, if the shares rally the bond will rise almost 1 for 1 with the underlying shares.

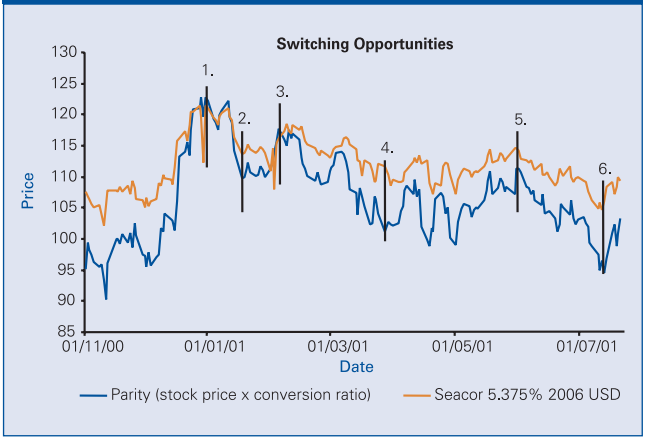
If they fall significantly, however, the convertible should fall by much less. After a decline in the stock, premium will have opened out and the investor can switch back into the shares in anticipation of the next rally.

In order to emphasise the success of this strategy, we have made our 'switches' at the most advantageous moments, but even a simple predetermined strategy such as:

Switch into convertible when premium < 5%
Switch back into shares when premium > 15%

would have outperformed simple 'buy and hold' strategies of either Seacor stock or the convertible.

Fig 26: Switching Strategy at Work - Seacor 5.375% 2006 USD



Source: Deutsche Bank Convertible Research

Having identified the switching points we can look at the P/L of the strategy (Table 9). The P/L is simple to calculate. At the first point (12/01/01), we switch from the stock into the convertible. The convertible falls -7.42% to the next

Table 9: P/L of the Switching Strategy					
Date	**Switch**	**CB Price**	**Parity**	**CB Gain (Loss)**	**Parity Gain (Loss)**
12/01/01	Switch into CB	123.00	122.159		
22/01/01	Switch out of CB back into Stock	113.875	109.94	**-7.42%**	-10.00%
08/02/01	Switch out of Stock back into CB	119.00	1117.72	4.5%	**7.08%**
30/03/01	Switch out of CB back into Stock	111.75	101.13	**-6.09%**	-14.09%
06/06/01	Switch out of Stock back into CB	114.25	111.36	2.24%	**10.12%**
19/07/01	Switch out of CB finally back into Stock	106.00	94.56	**-7.22%**	-15.09%

Source: Deutsche Bank Estimates

switching point (22/01/01), but parity is down -10.00%. Premium has expanded and so we switch back into the stock at 22/01/01. The switching then goes on until 19/07/01 when we switch back into the stock for the final time.

The results of this strategy (although exaggerated by the effect of hindsight) are impressive.

The investor who employed the switching strategy achieved an almost flat performance, even though Seacor stock fell almost 23%. But all the time the investor retained exposure to the underlying shares.

Table 10: 'Switching' - Total Return Analysis				
	Strategy	**Price Gain / Loss**	**Yield**	**Total Return**
1	Hold Stock	-22.59%	0.0%	-22.59%
2	Hold Convertible	-13.82%	2.76%	-11.06%
3	Switching	-3.53%	1.50%	-2.03%

Source: Deutsche Bank Estimates

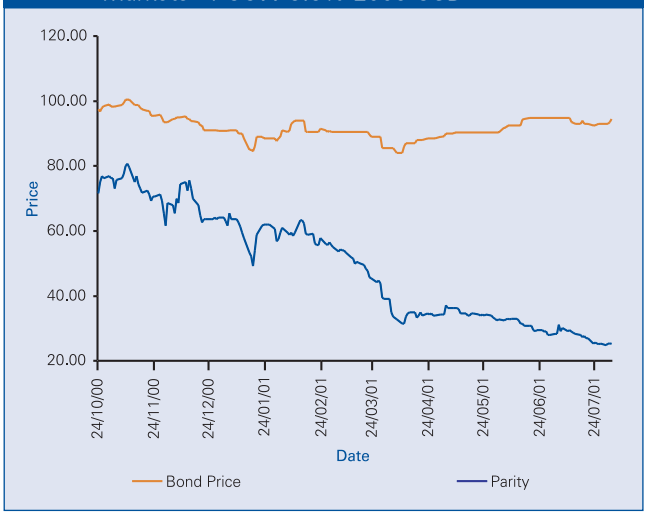
Convertibles also offer a number of other attractions for equity investors:

1. Reasonable Liquidity - Particularly in Europe, convertible and exchangeable issue sizes have increased a great deal in the last couple of years. This has resulted in much better liquidity in convertible bonds than was the case in the mid 1990s. Equity 'switchers' will generally get good prices from convertible market makers if they sell (buy) the shares and buy (sell) the convertible as part of the same transaction, because the market maker will be naturally hedged. Convertibles can even offer better liquidity than the underlying shares in certain cases. In some markets, most notably the Asia Pacific region, a large Euroconvertible issue can be the most liquid way to gain exposure to the underlying shares, especially if they do not have ADRs or GDRs outstanding.

Convertibles can also offer exposure to local shares when foreign share limits have been exhausted. Many convertibles in the Asia Pacific region are convertible into local shares, so investors have exposure to the local securities without having to own them physically.

2. Broadens Investment Horizons - Convertibles can have the effect of turning more speculative shares / markets into much safer investments. An example might be a stock like Pacific Century Cyberworks in Hong Kong. In October 2000, an investor who thought the story looked interesting but who was nervous of an outright investment in the stock could have bought the PCCW 3.5% 2005 USD convertible instead. As it turned out, October 2000 was too early to buy the stock, and it more than halved in the next nine months. But the convertible limited the loss to -6% only, including the interest. The investor was wrong but lived to fight another day, whereas a big outright position in the stock would have been a painful experience indeed!

Fig 27: Convertibles Offer a Safer Investment in Difficult Markets - PCCW 3.5% 2005 USD



Source: Deutsche Bank Convertible Research

A convertible position also buys an equity investor time to exit a market more gradually if it experiences sudden weakness. This is because the convertible will fall much more slowly than the underlying shares and a large position can be unwound over a longer period.

3. Currency Protection - Cross currency convertibles (bonds denominated in a currency other than that of the underlying shares) give equity investors inexpensive currency protection in volatile markets. US investors very often buy US dollar denominated convertibles on European stocks. These convertibles participate in European currency appreciation through an appreciation in parity, but are protected from large falls in the local currency by the redemption value in USD.

   This feature of convertibles is also what drove the US dollar denominated Asian Euroconvertible market in the mid 1990s, and is still driving issuance from that region today (2001).

6. Convertibles for Hedge Funds

Since we wrote our first Investors' Guide in 1997 perhaps the most important development in the market has been the explosive growth of the convertible hedge fund industry. It is guestimated that arbitrage funds now own as much as 50% of the world's USD 450 billion stock of convertible securities! On any given day in Europe or the US, hedge fund trading can represent up to 75% of convertible volumes. Any investor or issuer involved with convertibles should have at least some idea what these funds do.

Hedge funds differ from outright investors in that they do not generally take directional views, and instead try to exploit relative valuation anomalies in the market through the use of leverage. Within convertibles, hedge funds buy convertibles and short shares against them to try to isolate undervalued equity options.

In our opinion, a lot of ill-informed comment has been written about the operation of convertible arbitrage funds, but we believe that such funds have had a demonstrably beneficial effect in four crucial areas:

1. Efficiency of Pricing - ensuring that convertible securities trade closer to their theoretical or 'fair' value, ensuring that the full economic benefit of these instruments accrues to *all* investors and issuers.

2. Promoting Liquidity - frequent trading by arbitrage funds has dramatically improved liquidity, in Europe particularly.

3. Product Innovation - the convertible asset swap and credit default swap markets have developed largely as a result of their activities, to name but two innovations.

4. Issue Size Increases - the new demand for convertible securities has resulted in a significant increase in issue sizes in Europe and the US.

Convertibles, like other derivative instruments, are good for arbitrage investing as two assets (the convertible and the underlying shares) trade with predictable correlations (at least theoretically). This allows a (theoretically) risk-free portfolio to be constructed with a long convertible position hedged with a short position in stock. Ignoring, for the moment, the problem of credit exposure, the portfolio should display all the characteristics of a hedged equity call option, with the call struck at the conversion price and maturing at the maturity of the convertible.

We will deal with more of the complexities later, but first let's examine a simple long convertible/short stock delta hedging scenario.

The concept of delta is the first thing we need to understand. Convertible delta is the bond's price sensitivity to movements in the underlying share price. It is the 'equity sensitivity' of the convertible.

$$\textbf{Delta} = \frac{\Delta \textbf{Convertible Price}}{\Delta \textbf{Stock Price x Conversion Ratio}}$$

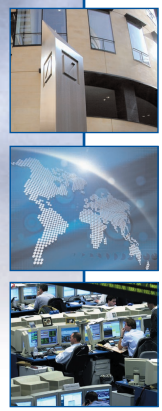
Given that it is a hedge ratio, it must also follow that:

$$\Delta\textbf{(Delta x Stock Price x Conversion Ratio)} = \Delta\textbf{Convertible Bond}$$

for any small movement in the share price.

It is clear from this equation that in order to calculate delta we have to understand the theoretical price change of the convertible. In fact, it is only possible to do this accurately by using a convertible model such as those described below, from which delta is derived from observations of a lattice-based (binomial or trinomial) tree.

We assume that our model gives us 60.00% as a delta for Ahold 4% 2005 EUR, and that we are hedging EUR



1,000,000 of bonds. The following facts are relevant:

Nominal Value	**= EUR 1,000**
Conversion Ratio	**= 31.0463 shares per bond**
Share Price	**= EUR 29.60**
Parity	**= 91.90**
Convertible Price	**= 100**

The hedge calculation is:

Delta x (Conversion Ratio x No. of Bonds) = shares to be shorted

60% x (31.0463 x 1,000) = 18,628 shares

We can check that this is the correct hedge by running a scenario. If we increase the share price by 2%, parity will be 93.74, and our model tells us that the bond should trade at 101.10. Let's look at the P/L of our hedged portfolio to check that we were correctly hedged:

Table 11: Initial Position	
Long	
1,000 bonds (EUR 1,000 nominal) @100	= EUR 1,000,000
Short	
18,628 shares @ E 29.60	= EUR 551,389

Source: Deutsche Bank Estimates

We now increase the share price by 2% to EUR 30.19

Table 12: Position after 2% Share Price Rise	
Long	
1,000 bonds @ 101.10	= EUR 1,011,000 **+ EUR 11,000**
Short	
18,628 shares @ EUR 30.19	= - EUR 562,379 **= - EUR 10,990**

Source: Deutsche Bank Estimates

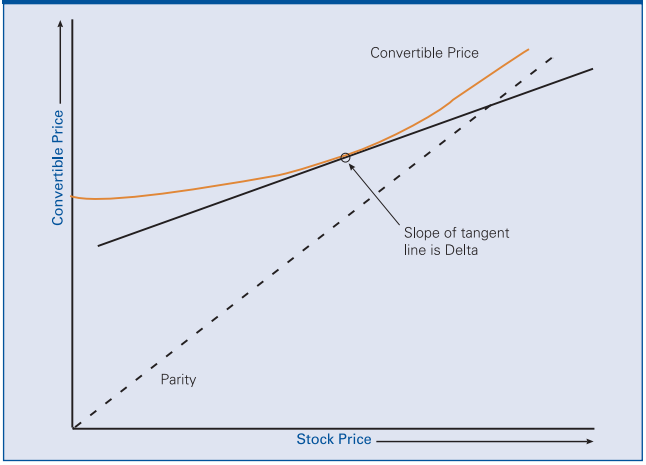
We can see the hedge ratio of 60% was correct, given that the net P/L of the entire position was almost unchanged.

So, a convertible's delta is a key number. It determines how many shares must be shorted to isolate the arbitrage portfolio (long convertible / short stock) from small movements in the underlying stock.

So far, so good. But we haven't actually made any money yet! In fact, as a hedge fund, we might even have lost money on the position above because our prime broker may be charging us interest on the (probably) leveraged position, and we will almost certainly be paying a fee to borrow the shares we shorted. Clearly, small stock moves are not going to be much help. But what about larger ones?

Figure 28 shows that convertible delta does not remain constant, but changes as the convertible's profile changes. The change is attributable to gamma, which we shall explain more fully overleaf.

Fig 28: Delta is the Slope of a Tangent Drawn on the Convertible Price Line



Source: Deutsche Bank Estimates

Table 13: A Greater Move in the Underlying Shares Produces a Larger Gain for the Hedged Portfolio

Date	Convertible	Stock Price (EUR)	Hedge Ratio at Outset	New Theo. Delta	P/L on Portfolio (EUR)
14/08/01	118.81	35.52	60.00%	70.00%	+10,422.24
14/08/01	106.74	29.60	60.00%	60.00%	0.00
14/08/01	97.54	23.68	60.00%	50.00%	+18,277.76
Note: The P/L on the portfolio is based on long EUR 1,000,000 bonds / short 18,628 shares					

Source: Deutsche Bank Estimates

If we move Ahold's share price up and down by 20% instead of 2%, the hedge portfolio returns become much more interesting, as Table 13 illustrates.

Table 13 demonstrates that the initial hedge of 60% only keeps the P/L constant for small movements in the equity price. For greater moves, the convertible is affected by gamma (the rate of change of delta).

Gamma

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

$$\text{Gamma} = \frac{\Delta\text{Delta}}{\Delta\text{Parity}}$$

Investors need to be very careful with gamma units. Our favourite expression of gamma is of points change in delta for 1 percentage move in the stock. This methodology is attractive because it means that gammas are readily comparable across different securities. But convertible models will often express gamma in terms of points change in delta for a one point move in stock price, and we revert to this latter methodology below.

Like delta, gamma has to be derived from the binomial (or other) tree, and once again it is derived from observations in the tree itself.

Table 14 shows that delta alone is a very accurate measure of the future value of Ahold 4% 2005 EUR for rise in parity of one point.

However, for a larger move of 10 points in parity, only using the initial delta results in an unacceptably large error, as Table 15 demonstrates.

Table 14: Ahold 4% 2005 EUR - Parity Rises by 1 point

Convertible Price	Parity	Delta	Parity (+ 1 point)	Theo. Price using initial delta	Theo. Price using full model	Difference
106.74	91.90	60.00%	92.90	107.34	107.35	0.01%

Source: Deutsche Bank Estimates

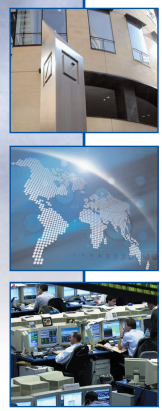


Table 15: Ahold 4% 2005 EUR - Parity Rises by 10 points						
Price	**Parity**	**Delta**	**Parity** (+ 10 points)	**Theo. price using initial delta**	**Theo. Price using full model**	**Difference**
106.74	91.90	60.00 %	101.90	112.74	113.94	1.06%

Source: Deutsche Bank Estimates

To predict the convertible price for larger movements in parity we apply the gamma equation:

(Delta x expected move in parity in points) + ½ (Gamma in points) x (Expected move in parity in points)²

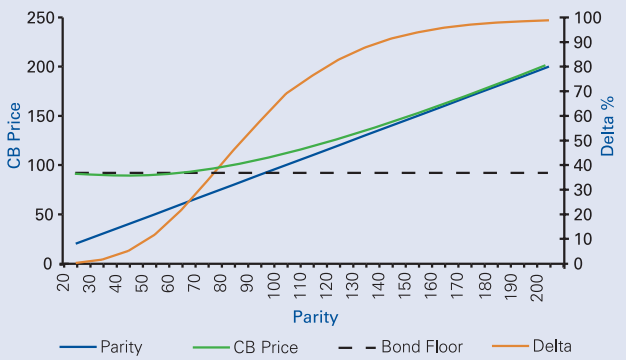
Table 16 (below) shows that the application of the 'gamma correlation' to delta results in a much more accurate result.

Convertible gamma is clearly another key variable for hedge fund investors.

A look at the delta profile for Ahold 4% 2005 EUR (Figure 29) shows that delta changes significantly at different stock prices.

The point of maximum gamma is often the most attractive point at which to 'set-up' a convertible with a risk neutral hedge. For Ahold 4% 2005 EUR, this point would be when parity is around 80.0 (Figure 30).

Fig 29: Ahold 4% 2005 EUR - Delta Profile



Source: Deutsche Bank Estimates

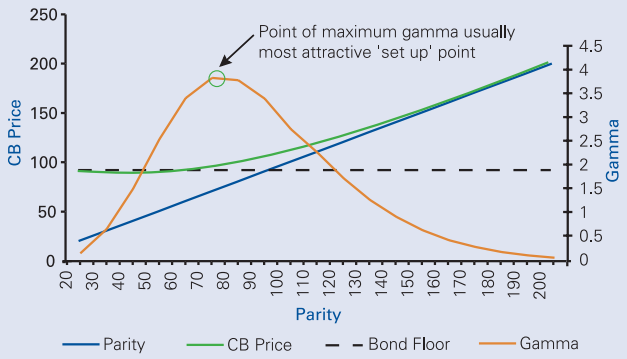
Capturing Volatility

In order to make money with hedged 'risk neutral' portfolios of long convertible and short stock, it is necessary for investors to 'capture' stock volatility by trading the portfolio. When parity rises (falls) and delta rises (falls) more stock is sold short (bought back) to keep the portfolio 'delta neutral'.

Table 16: Ahold 4% 2005 EUR - Parity Rises by 10 points - Application of 'Gamma Correlation'						
Price	**Parity**	**Delta**	**New Parity (+10 points)**	**Theo. price using initial delta only**	**Theo. price using Delta and Gamma**	**Theoretical Price from Model**
106.74	91.90	60.00	101.92	112.74	113.67	113.94

Source: Deutsche Bank Estimates

Fig 30: Ahold 4% 2005 EUR - Gamma Profile



Source: Deutsche Bank Estimates

The P/L of selling stock high and buying it back low is what makes up 'gamma trading profits'.

A convertible arbitrageur hedging the portfolio continuously will return exactly the risk free rate if he 'captures' exactly the volatility 'implied' by the convertible. This is the definition of 'implied' volatility.

High gamma is good because the large changes in delta, even for small movements in the shares, give an arbitrageur the opportunity to capture more P/L because they will be rehedging *more* shares, *more* frequently (i.e. selling when they go up and buying when they fall). This will result in a higher 'gamma trading' P/L than would have been the case for a lower gamma name.

Returning the risk free rate is better than making no money at all, but again, the arbitrageur is hoping to do rather better. In fact the convertible hedge fund is hoping for one (or all) of three things:

1. To capture more volatility than that 'implied' by the convertible over a longer time period; and / or
2. To capture a short term volatility 'event'; and/or
3. To capture a Vega 'richening' of the convertible (explained a little later).

1. Capturing Excess Volatility

Convertibles are issued, and often trade, at an implied volatility below the level of volatility arbitraguers would expect to capture by gamma trading the stock. Indeed no arbitrageur would buy a convertible if this were not the case, as they would almost be guaranteed to lose money!

So the most basic strategy is to buy bonds where the arbitrageur expects to be able to capture more volatility than that implied by the bonds.

2. Capturing a Volatility 'Event'

Convertible arbitrageurs often 'set up' portfolios where they expect some short-term volatility event.

An example of a profitable (and realistic) short term 'set up' of Ahold 4% 2005 EUR might have been over year end 2000/01. We assume that a EUR 10 million portfolio was established on 29 December 2000 (Table 17):

Table 17: Ahold 4% 2005 EUR - 'Millennium Set Up'

	29 Dec 2000	15 Jan 2001
Ask Price	117.00	109.00
Parity	106.68	94.38
Stock Price	EUR 34.36	EUR 30.40
Delta	74.50%	66.43%

Source: Deutsche Bank Estimates

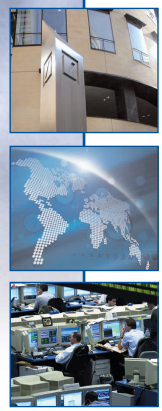


Table 18: Portfolio:		
	29 Dec 2000	**15 Jan 2001**
Long EUR 10million	EUR 11,700,000	EUR 10,900,000
Short 231,295 shares	- EUR 7,947,296	- EUR 7,031,368

Source: Deutsche Bank Estimates

So now we can look at the overall profitability of the position:

Table 19: Portfolio: P/L	
- EUR 800,000	**long bonds**
+ EUR 915,928	**short stock**
+ EUR 115,928	**positive P/L**

Source: Deutsche Bank Estimates

In this example, we have ignored the issue of funding. Adding in the funding reduces the profit somewhat, but this would still have been a very profitable strategy and the sort of position that hedge funds routinely look for.

Funding and Margining

It is important at this stage to look more carefully at how convertible arbitrage positions are funded, because this is very relevant for positions that are going to be run for any length of time. Arbitrage positions such as the ones described above will almost always be held with an investment bank or 'prime broker', who will calculate the required margin on the position and the funding (interest charge).

The prime broker should understand the way convertible hedges work and should require only the correct margin for the risk of the position being funded.

In assessing the margining requirement the prime broker will assess three things:

(i) Counterparty risk
(ii) Profile of the convertible security
(iii) Effectiveness of the convertible hedge

(i) Counterparty Risk

The counterparty will be tiered according to the level of risk associated with the fund. The fund's size, strategies employed, level of diversification and the experience of the managers will all be taken into account.

(ii) Convertible Portfolio

How an individual position is assessed depends on whether it forms part of a diversified strategy or not. A theoretically hedged position in a good quality name will probably be assessed according to simple profile rules such as those in Table 20.

Table 20: Margin Rules for Convertible in Diversified Portfolio	
Low Delta Convertible	x% of notional (usually below 10%)
High Delta Convertible	Cash Premium Only

Source: Deutsche Bank Estimates

However, a single convertible position, that does not form part of a diversified portfolio, will be assessed more harshly:

Table 21: Margin Rules for Convertible in Isolation	
Low Delta	3 x % notional
Mid Delta	2 x % notional
High Delta	Cash Premium Only

Source: Deutsche Bank Estimates

Table 22: Deviating from Theoretical Hedge Requires Higher Margin Charge

	Theoretically Hedged Portfolio		Non-Theoretically Hedged Portfolio	
1.	Long EUR 10 million Ahold 4% 2005 EUR		**2.**	Long EUR 10 million Ahold 4% 2005 EUR
	Theo Delta	= 74.50%		Theo Delta = 74.50%
	Actual Hedge (74.50%)	= 231,295 shares short		Actual Hedge (60%) = 186,278 shares short
	Naked Stock Position	= 0		Naked Stock Position = 45,017 shares (long)
	Margin Required if Convertible Price is 117:			**Margin Required if Convertible Price is 117:**
	(EUR 10 million x 117%) x 5%[1]	= EUR 585,000		(EUR 10 million x 117%) x 5% = EUR 585,000
				(45,017 shares x EUR 34.36) x 20%[2] = EUR 309,357
	Margin	**= EUR 585,000**		**Margin = EUR 894,357**

[1] 5% is an assumption and not necessarily the rate a prime broker would charge. [2] Assumed margin. For a very volatile stock this could be higher.

Source: Deutsche Bank Estimates

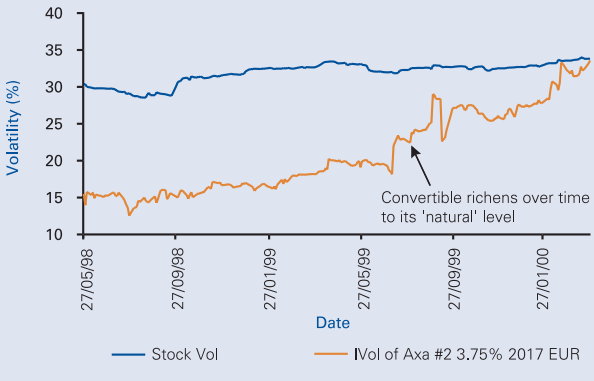
(iii) Effectiveness of Convertible Hedges

Using its own database, the prime broker will also calculate the correct delta for the position and will judge the client's actual position against this. Any deviation from the theoretical hedge will generally be treated as a naked equity long / short. Naked equity positions will usually attract a higher margin penalty. Consider two different Ahold 4% 2005 EUR positions in a diversified portfolio of convertibles (Table 22).

3. Capturing Vega Richening

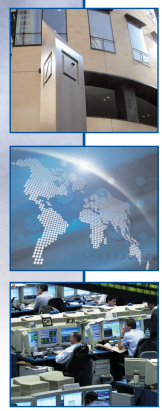
The rule that convertibles (and other options) always trade at theoretical value at maturity is always worth remembering. But often a convertible arbitrageur will not have to wait until maturity for the market to re-evaluate an undervalued convertible. The implied volatility graph (with 260 day stock volatility overlaid) for Axa #2 3.75% 2017 EUR shows clearly that bonds that have been artificially depressed by some event (in this case excess issuance from Axa) will richen of their own accord over time (Figure 31).

Fig 31: Axa #2 3.75% 2017 EUR - Implied Volatility and Stock Volatility



Source: Deutsche Bank Convertible Research

Figure 31 shows that arbitrageurs should not be too concerned with short-term market sentiment. Providing the



potential for arbitrage exists, bonds will richen/cheapen to their correct level over time.

The richening (cheapening) of convertibles with changes in underlying stock volatility is estimated by Vega.

Vega

Vega is the sensitivity of the convertible price to changes in implied volatility. Vega is usually expressed as the change in convertible price in points for a one percent point increase in implied volatility.[6]

$$\text{Vega} = \frac{\Delta \text{Convertible Price}}{\Delta \text{Volatility Stock}}$$

Vega is used in both P/L projection and in risk management. Let's return once again to our Ahold example:

Long EUR 10 million Ahold 4% 2005 EUR

Table 23: Vega Effect on Ahold 4% 2005 EUR

IVol% of convertible	Vega [per 1% move in IVol]	Convertible Price
28.1%	0.49625	117.00

Source: Deutsche Bank Estimates

An investor has bought the bond on an implied volatility of 28.1% on the assumption that it will richen by 3 IVol (implied volatility) points to 31.1%. Ignoring the stock short, funding etc., in this case the investor would make:

Table 24: Vega Effect on Ahold 4% 2005 EUR

Old Ivol	New Ivol	Move (in IVol points)	Vega (per 1%)	New Price	P/L (EUR)
28.1%	31.1%	+3	0.49625	118.49	+149,000

Source: Deutsche Bank Estimates

Conversely (in risk management terms) if the whole market were to cheapen and the bonds were to lose 3 implied volatility points, the effect would be as in Table 25.

Table 25: Vega Effect on Ahold 4% 2005 EUR

Old Ivol	New Ivol	Move (in IVol points)	Vega (per 1%)	New Price	P/L (EUR)
28.1%	25.1%	-3	0.49625	115.51	-149,000

Source: Deutsche Bank Estimates

Rho

We have already dealt with credit protection for convertibles in Chapter 4. However, we should also cover simple Rho hedging for convertible positions.

A convertible's Rho is its sensitivity to movements in interest rates.

$$\text{Rho} = \frac{\Delta \text{Convertible Price}}{\Delta \text{Interest Rate}}$$

For fixed income investors, Rho will be familiar as Adjusted Modified Duration. Rho is usually expressed as the points move in a convertible price for a 1 basis point move in interest rates (uniform curve shift is usually assumed).

Rho indicates what hedge is required for changes in interest rates. For example, the Rho of Ahold 4% 2005 EUR in all the above examples is 0.012, which means that if interest

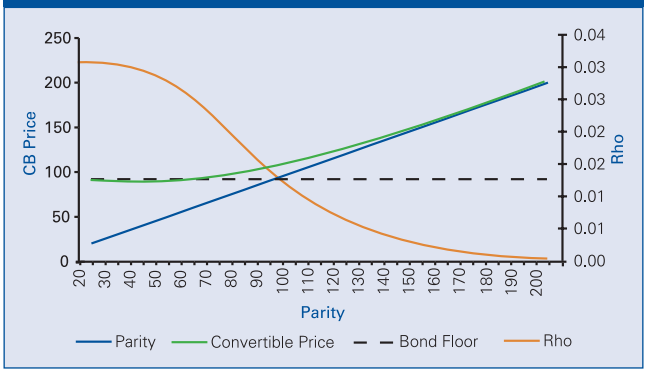
[6] Vega can also be applied to interest rate volatility in exactly the same way. This is useful in two factor convertible models where the volatility of interest rates is taken into account when constructing the model:

$$\text{Vega} = \frac{\Delta \text{Convertible Price}}{\Delta \text{Volatility Interest Rate}}$$

rates rise by 1 basis point, the bond price should fall by 0.012 points.

Investors with long convertible positions will hedge their interest rate exposure with reference to this Rho number. For convertible arbitrage funds and market makers, Rho hedging is usually an approximate affair. Usually a liquid futures contract in the currency of the bond is used as the hedging vehicle. A long position of EUR 10 million nominal in Ahold 4% 2005 EUR, on the 3 September 2001, would require a hedge as shown in Figure 33 below:

Fig 32: Rho Declines as Delta Increases - Ahold 4% 2005



Source: Deutsche Bank Estimates

Rho becomes progressively less important as parity and delta rise (Figure 32).

Theta

All options have 'time value'. The longer the option exists for, the more it is worth.

Theta is the rate of change in the convertible price over time. Theta is usually expressed as the change in theoretical convertible price over one day.

$$\text{Theta} = \frac{\Delta \text{Price}}{\Delta \text{Time}}$$

Convertible theta is more complex than a simple option theta because the time decay of the call option can be offset by the accretion of the bond to its redemption value. Accretion can mean that deep OID (Original Issue Discount) structures can have positive theta, as the capital appreciation of the bond to maturity is greater than the level of time decay in the call option.

In fact, in September 2001, over 75% of the European convertible universe had positive theta!

Again, we can see the impact of theta on the Ahold 4% 2005 EUR bond in Tables 26 and 27.

Fig 33: Rho Hedging of Ahold 4% 2005 EUR

Nominal Bonds / Contract Size Of Future	x	Price of Bond / Price of CTD Of Future	x	Rho of Bond / Modified Duration Of Future	x	Conversion Factor of Future
EUR 10 m / 100,000	x	114.125 / 101.363	x	0.012 / 4.28%	x	0.939069 = 30 contracts

Source: Deutsche Bank Estimates

Table 26: Theta in Ahold 4% 2005 EUR			
Date	**Theo Price**	**Parity**	**Theta/day**
11 July 2001	121.75	113.78	0.009504

Source: Deutsche Bank Estimates

The theta in Table 26 of 0.0095 per day would imply that one year later in time the bond would have 'decayed' to the level in Table 27. Table 27 implies that theta is a linear function, though in fact the rate of theta decay is a complex function of time to maturity, convertible profile and other factors.

Table 27: Theta in Ahold 4% 2005 EUR	
Date (+365 days)	**New Theoretical Value**
11 July 2002	(-0.0095 x 365) = -3.46 121.75 - 3.46 = 118.29

Source: Deutsche Bank Estimates

The above table will only accurately predict the new theoretical value if no other variables change but time, it is certainly an important metric, and one that is constantly assessed by arbitrageurs.

Convertible Modelling

Most of the analysis above has relied on the calculation of theoretical values, implied volatilities and other metrics such as delta, gamma, vega, rho and theta.

These numbers are all derived from convertible models. We now turn our attention to how these models are constructed. The shortcomings of simple bond plus options models have been exposed (in Chapter 2), where we saw that they cannot accurately take account of issuer call options and investor puts. In reality, nobody today uses this kind of analysis.

Lattice Based Modelling

Note: The following section draws on theoretical calculus and therefore maybe beyond the interest of some investors. The basic thread of our analysis can be picked up again by jumping straight to Chapter 7.

For readers who are interested in our modelling discussion, we use the notation set out by John C. Hull in his excellent *Futures, Options and other Derivatives, 4th Edition, 2000.*

The lattice approach allows an investor to build up a grid of possible stock (or other price) possibilities between now and the maturity of the convertible. This lattice is then used to find the present value of the convertible by calculating its value at different 'nodes'.

A 'one factor' model uses only stock price / parity as a variable. To build a lattice of expected parity values we start with the current share price. We decide in advance how many branches or 'nodes' the tree will have; the more nodes, the more accurate will be the model.

Between one node and the next, parity can either rise to P(u), or fall to P(d).

The amount the stock is assumed to rise or fall depends on the length of time to the next node (T-t) and the volatility of the underlying stock price (σ).

The notation is:

- e **= base of the natural logarithm (used to continuously compound interest rates). The continuously compounded 5% interest rate approximates to 5.127% ($e^{0.05}$ = 1.05127)**
- σ **= stock price volatility = 25%**
- **T = time at next node**
- **t = current time (so T-t = 1 in our one year, one step example below)**

An upward move (u) is defined as:

$$u = e^{\sigma\sqrt{(T-t)}}$$

$$u = e^{0.25x1} = 1.2840$$

Similarly, a downwards (d) move is:

$$d = e^{-\sigma\sqrt{(T-t)}}$$

It is also a condition that:

$$u = \frac{1}{d}$$

Therefore, if a convertible's parity is 80 currently and stock volatility is 25%, the expected upward / downward move over a 1 year period is:

P(u) = 1.2840 x 80

The downwards move is:

P(d) = 0.7788 x 80

Therefore, after one year, parity either rises or falls:

P(u) = 80 x 1.2840 = 102.72

P(d) = 80 x 0.7788 = 62.30

The tree must also have a 'drift component' because it is a central argument of risk neutral valuation that a risk-less portfolio of long bond / short stock can only return the continuously compounded risk-free rate. This means that there must be a greater probability of parity rising to P(u) than falling to P(d) in a positive yield curve environment. The probability (p) of an upwards move is:

$$p(u) = \frac{e^{r(T-t)} - d}{u - d}$$

and the probability of a downwards move is:

p(d) = 1 - p(u)

We will assume the 1 year zero coupon risk free rate is 5%. Continuously compounded this approximates to 5.127%.

The probability of an upwards move is therefore:

$$p(u) = \frac{1.05127 - 0.7788}{1.284 - 0.7788}$$

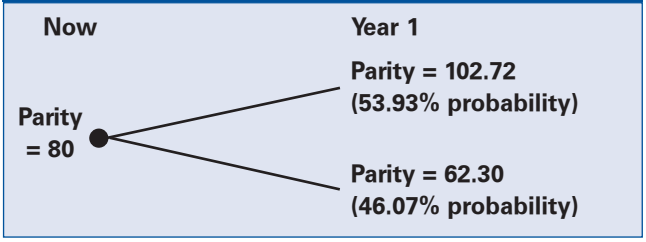
p (u) = 0.53933

and

p (d) = 0.46067

So a one year, one node model looks like Figure 34.

Fig 34: One Node Binomial Tree



Source: Deutsche Bank Estimates

Summing these values and probabilities

(102.72 x 0.53933) + (62.30 x 0.46067) = 84.10

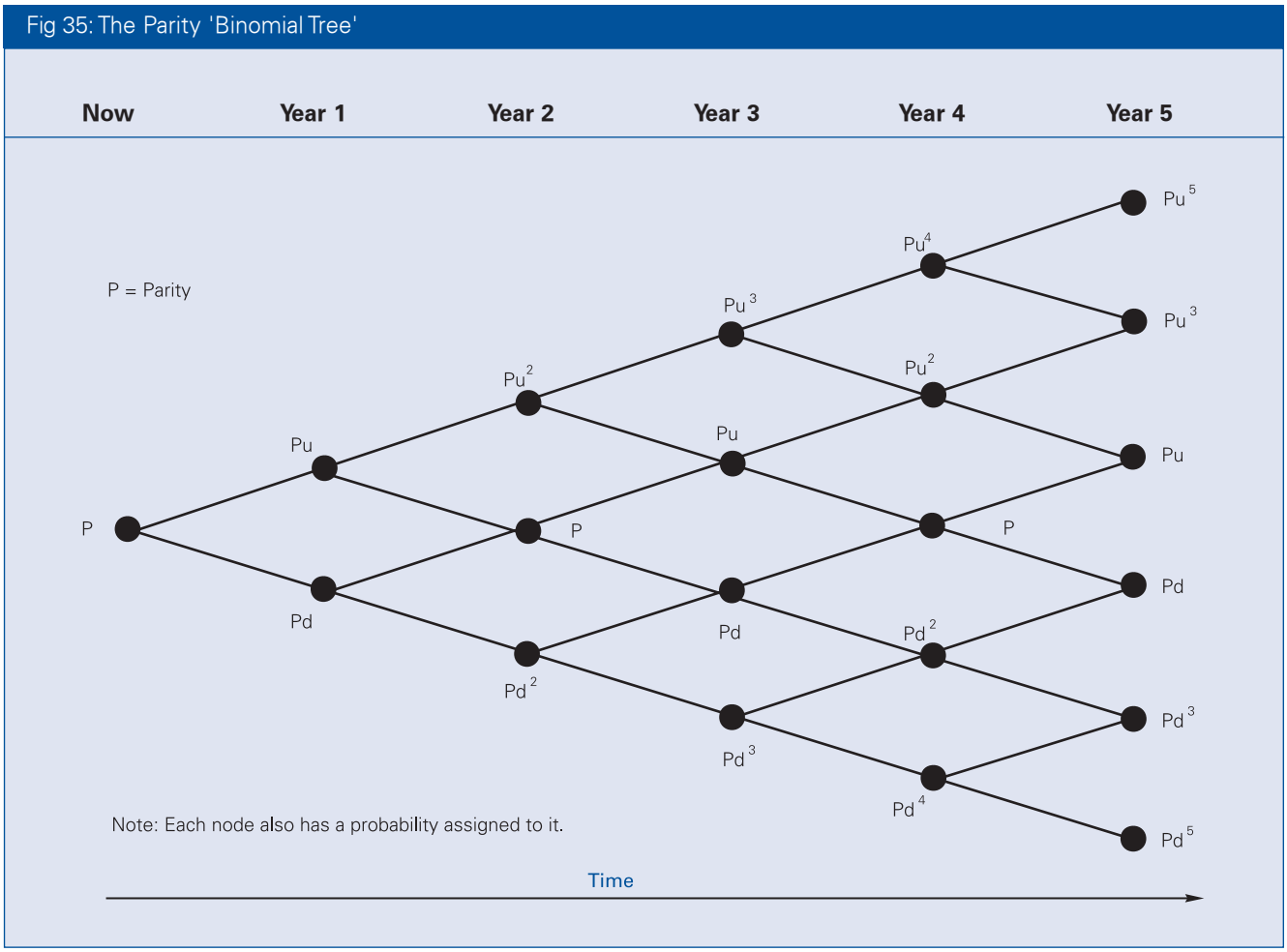
This is exactly what we expect, as 80 $e^{r(T-t)}$ = 84.10

Once we have the values for parity and the probabilities, the tree can be populated as shown in Figure 35.

Once the tree is populated with parity values, we work backwards from maturity calculating what the convertible is worth at each node to get to the present theoretical value. For simplicity, we will assume that the bond has no coupons, puts or calls, that the stock pays no dividends and that there are no borrow fees (we explain how these are dealt with later).

We start with the convertible value at maturity, which is known with certainty; because all derivatives are worth

Fig 35: The Parity 'Binomial Tree'



Source: Deutsche Bank Estimates

exactly their intrinsic value at maturity. At maturity, the convertible is worth the greater of: (1) Par + Final Coupon or (2) Parity.

We can illustrate the way the tree works by doing a very crude valuation of XYZ Corp 0% 2006 USD. We will build a very basic tree of just five nodes:

Node 5 (Year 5) - Maturity

We know that all parity values below 100 will return 100 as the convertible value (redemption amount). And all parity levels above 100 will return parity.

Node 4 (Year 4) - One Node Before Maturity

To get the values at Node 4 (one year before maturity), the convertible value will the greater of:

1. Parity; or

2. 'Continuation Value' (CV)

The 'continuation value' of the convertible (CV) is calculated using the next two node values multiplied by their probability and discounted at the risk free rate. A glance at the tree itself will make this clear (Table 28).

In order to calculate the theoretical value of the convertible at the circled node in year 4, we take the maximum of parity and the CV:

CV:

Discounted Expected Value:

$$= \frac{(102.716 \times 0.53933) + (100.00 \times 0.46067)}{1.05127}$$

= 96.516

As the CV is greater than parity, CV is the theoretical value of the convertible at node 4.

Working back through the tree, applying the above methodology, we arrive at a current theoretical value of 95.478. Our analysis reveals that this very crude five node analysis actually gives a theoretical value that is remarkably close to the value calculated using 250 nodes in a full binomial tree model.

Partial Derivatives From the Lattice

First and second derivatives (i.e. delta and gamma) can be obtained directly from empirical observations of the lattice. We will demonstrate how.

Starting from the 'Now' node and moving to Year 1, delta is computed as:

$$\text{Delta} = \frac{111.523 - 87.32}{102.72 - 62.304}$$

= 59.9%

Table 28: Simple 5 Node Binomial Tree Model of XYZ Corp 0% 2006 USD

Now	Year 1	Year 2	Year 3	Year 4	Year 5
					279.200
					279.199
				217.445	
				217.445	
			169.350		169.346
			169.349		**169.346**
		131.892		131.890	
		135.064		**131.890**	
	102.720		102.718		102.716
	111.523		**109.957**		**102.716**
80.000		79.998		79.997	
95.478		**96.374**		**96.516**	
	62.304		62.303		62.301
	87.320		**91.199**		**100.000**
		48.522		48.521	
		86.438		**95.123**	
			37.789		37.788
			90.484		**100.000**
				29.430	
				95.123	
Parity					22.920
Convertible Theoretical Value					**100.000**

Source: Deutsche Bank Estimates

Gamma

Gamma can be calculated using the change of delta between Year 1 and Year 2

$$\textbf{Delta 1} = \frac{135.064 - 96.374}{131.892 - 79.998}$$

$$= 74.56\%$$

$$\textbf{Delta 2} = \frac{96.374 - 86.438}{79.998 - 48.522}$$

$$= 31.57\%$$

Change in Parity:

$$131.892 - 48.522$$

$$= 83.37$$

Therefore, as parity moves 83.37 points, delta moves 74.56% - 31.57% = 42.99 points, and so parity gamma (i.e. the move in delta for a one point move in parity) is:

$$\frac{42.99}{83.37} = 0.516$$

Calls and Puts

Having built the basic tree, we can add boundary conditions very easily. If we want to assume that the bond is provisionally callable in Year 4 and 5, with a 140% trigger, we simply require that any parity value in those years that is greater than 140 (the provisional call trigger) will be the theoretical value at this node (i.e. for the model to assume conversion).

Absolute callability is approached in the same way. At any node where the bond is absolutely callable, the value at each node will be:

The greater of:

a) Parity

b) The lower of [CV and Call Price (including accrued interest)]

This is because if the CV is greater than the call price it will be in the issuer's interest to call the bonds; and conversion will be forced if parity is higher than the call price.

Call Cushions

Some models employ a 'call cushion', such that the convertible issuer will not call a convertible unless it is trading at a comfortable level above the conversion price (10% is usual). Although there is evidence that this is what issuers do in practice, it is difficult to arrive at an approximation of what this 'call cushion' should be. The addition of a cushion will lead to a higher, and less conservative, valuation.

Puts

Puts are added into the tree at the relevant node and a put is assumed to be exercised if the put value (plus accrued) is higher than both parity and CV.

Discount Rate

The question of which discount rate to use in the tree is still the subject of some controversy. 'Blended discount rate' models keep track of the bond and equity components of the convertible value at each node and discount the bond

component at the risk free rate plus credit spread and the parity component at the risk free rate only.

However, other models use the company's risky discount rate for the whole convertible value, using the argument that credit risk cannot be eliminated by hedging the bond with stock. The Black Scholes replicating portfolio of long bond / short stock would not accurately replicate the performance of the convertible unless the portfolio contained the same level of credit risk as the convertible.

In practice, the different approaches do not make much difference except when valuing Original Issue Discount (OID) structures (see below).

Coupons

Coupons are added to the appropriate nodes in the tree (i.e. at nodes where the convertible is assumed to be held - not converted - over a coupon pay date). The coupon is discounted back from the node at which it was added using the appropriate discount rate. Care needs to be taken where interest is lost on conversion to ensure that the correct decision is assumed.

Dividends

Stock dividends can easily be accommodated by growing parity at a rate equal to the risk-free rate minus the continuous dividend yield. If the dividends themselves are known, they are present valued and subtracted from parity before it is grown at the risk-free rate through the tree. In practice, trying to use actual dividends complicates the tree considerably, although it can be (and often is) done.

Adding Second and Third Factors

The preceding analysis of a 'one factor' model assumes a constant interest rate and credit spread. Two and three factor models allow investors to model changes in interest rates and credit spreads.

Interest Rate as Second Factor

An interest rate tree is built up in the same way as the parity tree but with an equal probability of an upwards or downwards move. The up and down moves must conform to the present term structure of interest rates. The relationship between an 'up' and a 'down' move is given by:

$$Ru = Rde^{2\sigma\sqrt{(T-t)}}$$

At each node the model generates a quadrinomial tree with four branches SuRu, SuRd, SdRu and SdRd.[7]

Because of the generally low volatility of interest rates, this factor is often omitted from convertible models.

Credit Spread as a Second / Third Factor

Of much more interest to investors, especially in higher risk bonds, is the correlation between stock price and credit spread.

Any convertible investor understands this relationship instinctively. But from a technical perspective it is fairly easy to specify a condition that, below a certain share price, as the stock drops lower the credit spread widens. This is far more useful as a second factor, particularly outside the investment grade universe.

[7] Modelling interest rate volatility is a complex area. Interested readers are referred to Hull, Chapter 16.

7. What Drives Convertible Valuations Today?

The global convertible markets have travelled a huge distance since the mid 1990s. Until fairly recently, analysis of convertibles was still dominated by the concept of 'theoretical value'. Theoretical value was an easy concept to understand. It posited that a convertible was 'worth' whatever came out of a binomial tree model when the stock's historical volatility (and certain other assumptions) were keyed in.

To calculate 'theoretical value', two assumptions were generally made:

1. The underlying stock's 260 day historical volatility was used; and

2. Volatility was capped at 40%.

The problem with these assumptions was that they were completely arbitrary:

1. Why use 260 day stock volatility? Why not a shorter time period (100 day), or even a longer time period. The majority of convertibles are at least three year options. So why not use 780 day volatility?

2. Why cap the volatility at 40%? The traditional answer to this question was that convertibles 'would not trade richer than this'. But this is completely disproved now. Siemens / Infineon 1% 2005 EUR, amongst other bonds, has traded with an implied volatility well above 50% for long periods (quite justifiably).

So it is clear that we need to look well beyond simplistic conceptions of theoretical value if we are looking for what drives valuations in today's convertibles markets.

Arbitrage Funds Now Determine Valuations

Our first conclusion is that for the larger and more liquid issues, it is convertible arbitrage funds that now determine the pricing of convertibles.

This is not to say that outright accounts have no influence, and less liquid, or more 'out of the money', bonds are still primarily driven either by outright convertible investors or by buyers from other asset classes (such as high yield).

But for the balanced and liquid universe, wherever we look in the world, it is arbitrage funds that are able to mobilise the greatest liquidity to buy undervalued issues or to sell expensive ones. In the previous two chapters we looked at how credit protection could be used to separate the equity derivative component from the bond. We also looked at how convertible arbitrage works.

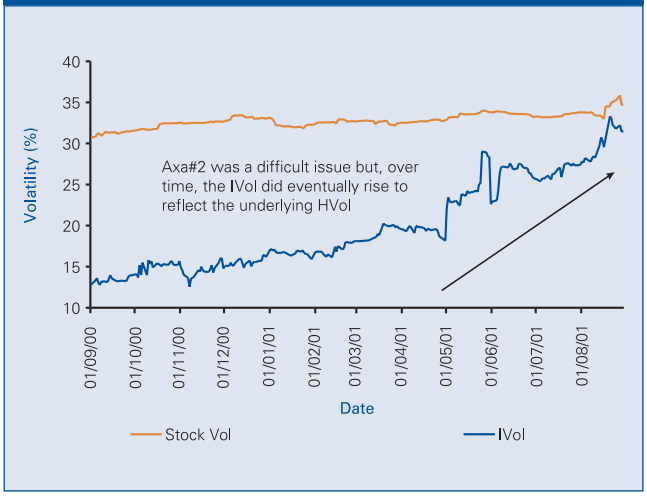
But what really makes an arbitrage fund think that a convertible is rich or cheap?

We believe a number of observations can be made about how valuations are driven in modern markets:

1. Bonds do not Stay Mispriced Forever

Our analysis suggests that convertibles do not remain undervalued for long periods if the potential for arbitrage exists. Even if bonds are 'tainted' following a weak debut or some disadvantageous corporate activity, they will recover over time. Axa #2 3.75% 2017 EUR is a good example of a bond which suffered a difficult birth and a certain amount of stigma in its early stages. But Figure 36 demonstrates that an implied volatility far below the historical volatility eventually leads to the bond richening to a more realistic valuation.

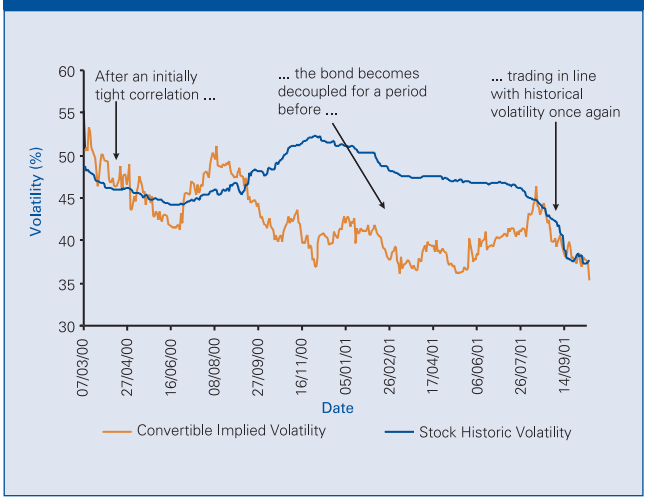
Fig 36: Axa #2 3.75% 2017 EUR



Source: Deutsche Bank Convertible Research

Similarly, after a period of dislocation, Allianz / Siemens 2% 2005 EUR has once again become more closely correlated with changes in the historical volatility of Siemens.

Fig 37: Allianz / Siemens 2% 2005 EUR

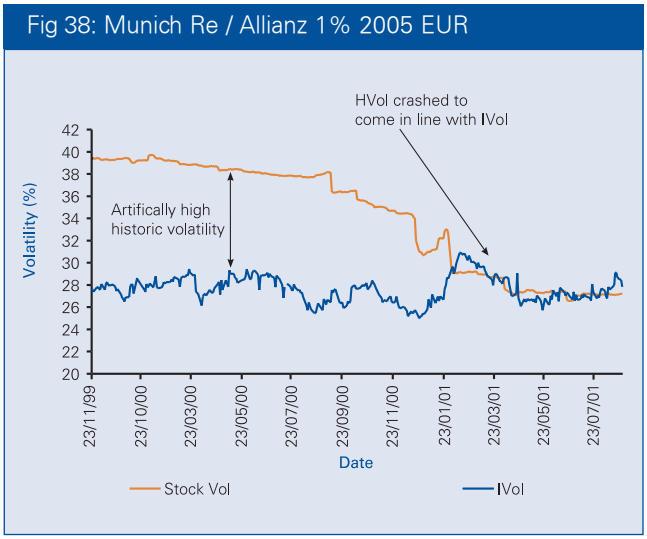


Source: Deutsche Bank Convertible Research

2. Historic Volatility of a Stock is Not Always a Good Guide to Valuations

Having emphasised the importance of historical volatility in convertible analysis, it is necessary to temper this by highlighting the drawbacks of historic volatility analysis *in isolation*. The major drawback, of course, is that historic volatility is a backwards looking indicator.

Fig 38: Munich Re / Allianz 1% 2005 EUR



Source: Deutsche Bank Convertible Research

Investors trading the Munich Re / Allianz 1% 2005 EUR bond were not fooled by the artificially high historic volatility of Allianz in late 2000, caused by speculation about potential corporate activity in the German financial sector.

And sure enough, it was the historic volatility that came crashing down to vindicate the more cautious stance of the convertible market.

The fact that historical volatility can often be a poor guide to future volatility is one of the reasons why investors are increasingly turning to the (forward looking) OTC and listed

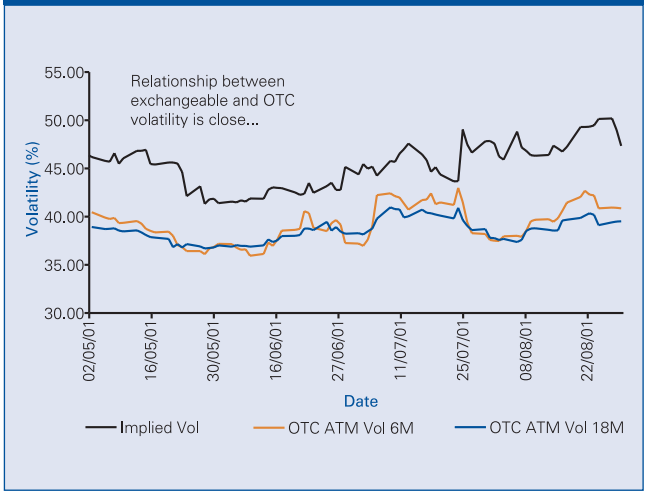
volatility markets for clues on where convertible valuations are going.

3. OTC / Listed Volatility is the Dominant Factor in Efficient Markets

Where continuous and stable credit protection exists, convertible valuations are driven to a greater and greater extent by pricing in OTC and listed volatility markets.

In Germany, an exchangeable such as Allianz / Siemens 2% 2005 EUR illustrates the point very well.

Fig 39: Allianz / Siemens 2% 2005 EUR

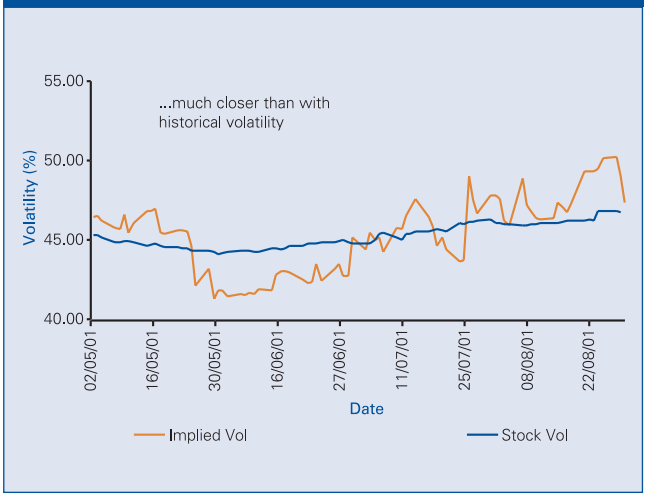


Source: Deutsche Bank Convertible Research

Figure 39 shows a close relationship between the short term ups and downs in the OTC volatility markets and the IVol of the exchangeable. It seems very clear that there is arbitrage activity between the two markets.

Figure 40 also demonstrates that there is a correlation between the historic volatility of Siemens and the IVol of the exchangeable, but it is clearly not as close or as useful to a trader as what is going on in the OTC / listed markets.

Fig 40: Allianz / Siemens 2% 2005 EUR



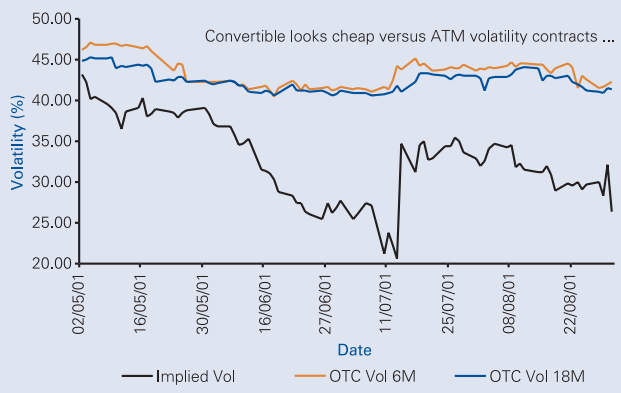
Source: Deutsche Bank Convertible Research

When using the OTC and listed volatility markets, it is important to isolate the correct volatility contract. We have used simple 'at the money' contracts (ATM) in our examples above, but it is very important not to apply an ATM volatility valuation to a deeply 'out of the money' or 'in the money' convertible.

Loews / Diamond Offshore 3.125% 2007 USD illustrates the point (Figure 41). The bond looks very cheap against ATM volatility at both 6M and 18M maturities. However, the problem is that the premium of 103.84% means a conversion price of USD 65.04, which is a long way above the stock price of USD 27.0.

A look at the volatility surface for Diamond Offshore for the 18M contract gives a clue as to why the exchangeable is trading where it is.

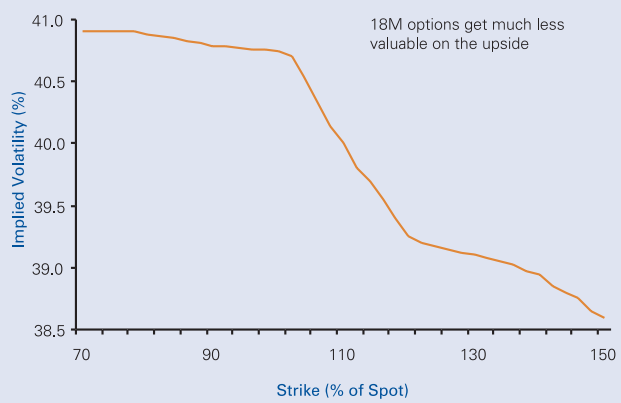
Fig 41: Loews / Diamond Offshore 3.125% 2007 USD



Source: Deutsche Bank Convertible Research

Figure 42 introduces the concept of volatility 'skew'. Skew reflects the fact that in the options markets, options with different strikes trade at different implied volatilities.

Fig 42: Diamond Offshore - Option Implied Volatility Skew



Source: Deutsche Bank Equity Derivatives Research

Options a long way out of the money, particularly to the upside, often trade much more cheaply than ATM options.

Figure 42 shows that at 150% of the current stock price, Diamond Offshore implied volatility in the options market falls to 38.5%. Interpolating this out to the almost 250% 'out of the money' exchangeable makes an implied volatility of 30% look reasonable.

The OTC / listed volatility markets are not just of use to the convertible analyst. The increasing availability of credit protection means that it is more and more common for hedge funds to sell OTC volatility against convertibles where significant disparities exist. While this can be a profitable strategy, it is fraught with difficulties due to:

1. Difficulty of matching strike and maturity (particularly the latter given the lack of liquidity in longer dated volatility markets); and

2. Documentation mis-match. The main problem here is a lack of standardization in what will happen to convertibles in corporate action scenarios versus what will happen to OTC / listed contracts (see Chapter 8: Documentation).

4. Hedge Funds and 'Busted' Convertibles

In our view, it is a misconception that arbitrage funds shun convertibles on which there is not credit protection available. But what they do will certainly have a bearing on how the convertible trades.

Consider a UK / US issue such as NTL 6.75% 2008 USD at issue. The convertible is rated B-/B3, and there is neither an asset swap nor a CDS offer available. A hedge fund has two choices: a) ignore the issue completely, or b) employ an 'overhedging' strategy.

Using comparisons with similar companies, we come up with a 'guesstimate' credit spread of about US LIBOR + 1,200 bps. Putting this spread into the model gives a theoretical delta of 68.74%. One strategy for the hedge fund might be to overhedge the position to protect against credit spread expansion. In the above scenario, if the stock were to fall by 50% the credit spread is likely to increase significantly. In this case, the convertible's realised delta will be much greater than that predicted by a one factor model.

So a hedge fund might overhedge by perhaps ten delta percentage points, perhaps 80% in the above NTL example, in order to allow for some credit spread expansion should the stock fall significantly.

8. Documentation

A great deal of progress has been made in convertible documentation in recent years (particularly in Europe). But it is still important for investors to understand the legal framework in which they are investing.

Contract Based Securities

Unlike most OTC derivatives, convertibles are not covered by generic documentation. Investors buy convertibles on the basis of a trust deed / indenture or other documentation which lays out the contract in detail. Before the trust deed is produced investors may have to work with a preliminary prospectus. But where a trust deed is produced it will always be the legally binding document, and differences between it and a preliminary prospectus will always be settled by reference to the trust deed (and we have seen many instances of this occurring).

An example of a prospectus (for KDIC / KEPCO 2.25% 2005 USD in Korea) is shown in Figure 43 opposite.

Trustees

When a trust deed has been issued, a trustee will normally act (in theory at least) in the convertible holders' interests in any dispute involving the issuer of the securities. While the trustee can make tiny adjustments to a trust deed, a full convertible holders' meeting is required to make any substantive change. The trust deed will set out the mechanics of how meetings are called and conducted.

Governing Law

It is very important to be aware of which governing law has been specified in the prospectus. If a dispute goes to litigation, this will govern where the case will be heard and the legal framework that will be applied.

Fig 43: KDIC / KEPCO 2.25% 2005 USD - Prospectus

20989 COV 1 KDIC Offering Memo 05 OCT 00 23:21
R. R. DONNELLEY HKG(●●) HKGraymo#00049 011 852 2522 3803

OFFERING CIRCULAR

예금보험공사
KOREA DEPOSIT INSURANCE CORPORATION

US$1,001,800,000
2.25% Exchangeable Notes due 2005 exchangeable into common shares or American Depositary Shares (subject to restrictions as provided herein) of

KEPCO
KOREA ELECTRIC POWER CORPORATION

Issue Price: 100.0%

The US$1,001,800,000 2.25% Exchangeable Notes due 2005 (the "Notes") of Korea Deposit Insurance Corporation ("KDIC") will bear interest from and including October 11, 2000 at the rate of 2.25% per annum payable semi-annually in arrears on April 11 and October 11 in each year up to, and excluding October 11, 2005. The Notes will be redeemed at 125.92% of their principal amount at maturity, unless previously redeemed, exchanged or purchased and cancelled. The Notes are rated BBB by Standard & Poor's Rating Service ("S&P") and Baa2 by Moody's Investors Service, Inc. ("Moody's"), which ratings are currently the same as those of the Government of The Republic of Korea.

Unless previously redeemed or purchased and cancelled, the Notes may be exchanged during the Exchange Period for a pro rata share of the Exchange Property comprising: (i) in the case of (x) holders of Restricted Notes and (y) holders of Unrestricted Notes that are U.S. persons (as further described herein), fully paid shares of common stock of Korea Electric Power Corporation ("KEPCO"), par value Won 5,000 per share (the "Common Shares" or the "KEPCO Shares") and (ii) in the case of holders of Unrestricted Notes that are not U.S. persons, at such holder's election, fully paid KEPCO Shares or American Depositary Shares of KEPCO (the "ADSs" or the "KEPCO ADSs"), each ADS representing the right to receive one-half of one KEPCO Share. The initial Exchange Property consists of approximately 32.4 million KEPCO Shares.

Upon exercise of the exchange right by a holder of Unrestricted Notes entitled to elect to receive ADSs, the number of ADSs to be issued will be calculated by dividing the principal amount of the Notes exchanged (translated into Won at the fixed rate of Won 1,117.9 = US$1.00) by an initial Exchange Price of Won 34,560 (subject to adjustment as provided herein) and multiplying the resulting number by two. On this basis, each US$1,000 principal amount of Notes will be initially exchangeable into approximately 64.7 ADSs. Upon exercise of the exchange right by a holder of Restricted Notes or a holder of Unrestricted Notes exchanging for KEPCO Shares, the number of KEPCO Shares to be issued will be calculated by dividing the principal amount of the Notes exchanged (translated into Won at the fixed rate of Won 1,117.9 = US$1.00) by the initial Exchange Price (subject to adjustment as provided herein). On this basis, each US$1,000 principal amount of Notes will be initially exchangeable into approximately 32.3 KEPCO Shares. See "Terms and Conditions of the Notes—Exchange". On October 2, 2000, the closing price of the KEPCO Shares on the Korea Stock Exchange was Won 27,000 per KEPCO Share and the closing price of the ADSs on the New York Stock Exchange was US$12.00 per ADS.

The Notes will be redeemable on October 11, 2003, at the option of the holders thereof, at 114.52% of their principal amount plus accrued interest to the date of redemption. The Notes will be redeemable at the option of KDIC, in whole or in part, on or at any time after October 11, 2003 at their Early Redemption Amount plus interest accrued to the date of redemption, provided that the Notes may not be so redeemed unless the Market Price per KEPCO Share has been at least 135% of the Exchange Price then in effect (see "Terms and Conditions of the Notes—Redemption, Purchase and Cancellation"). The Notes may also be redeemed by KDIC at their Early Redemption Amount in the event of the imposition of certain Korean withholding taxes or in the event that at least 90% of the original issued principal amount of the Notes have been redeemed, exchanged or purchased and canceled.

Application has been made to list the Notes on the Luxembourg Stock Exchange. Application will be made to have the Notes designated as eligible for trading in the Portal Market of the Nasdaq Stock Market, Inc. ("Portal").

The Notes will be in registered form and will be issued in minimum denominations of US$1,000 and integral multiples thereof (provided that the Restricted Notes will be issued in minimum denominations of US$500,000 and integral multiples of US$50,000 in excess thereof).

The Notes and the KEPCO Shares deliverable upon exchange of the Notes have not been, and will not be, registered under the United States Securities Act of 1933, as amended (the "Securities Act"), or with any securities regulatory authority of any jurisdiction. The Notes and the KEPCO Shares deliverable upon exchange of the Notes may not be offered or sold in the United States except as set forth herein. The Notes will be offered and sold (i) to non-U.S. persons in offshore transactions outside the United States in reliance to Regulation S under the Securities Act ("Regulation S"), and (ii) in the United States to qualified institutional buyers (each a "QIB") as defined in and in reliance on Rule 144A under the Securities Act ("Rule 144A") who are also qualified purchasers (as further described herein) within the meaning of Section 2(a)(51) of the United States Investment Company Act of 1940, as amended. Prospective purchasers are hereby notified that sellers of the Notes may be relying on the exemption from the registration provisions of Section 5 of the Securities Act provided by Rule 144A. See "Transfer Restrictions".

See "Risk Factors" beginning on page 15 for a discussion of certain matters that should be considered by prospective investors.

The Notes are offered by the Managers, subject to prior sale, withdrawal, cancellation or modification of the offer without notice and to certain further conditions. It is expected that delivery of the Notes will be made through the facilities of The Depository Trust Company (and through its participants) on or about October 11, 2000.

Joint Bookrunners
Deutsche Bank **UBS Warburg**
Joint Global Co-ordinators
UBS Warburg **LG Investment & Securities** **Deutsche Bank**
Joint Lead Managers
Deutsche Bank **LG Investment & Securities** **Morgan Stanley Dean Witter** **UBS Warburg**
Financial Advisor
LG Investment & Securities

The date of this Offering Circular is October 4, 2000

Source: Korea Deposit Insurance Corporation, Korea Electric Power Corporation

Terms and Conditions

The 'Ts & Cs' are the real bones of the documentation, and are where investors need to be especially focused. The basic information is usually straightforward, but problems can arise in the following areas:

1. 'Capital' Distributions to Shareholders (including special dividends);
2. Issuer Calls ('Screw' Clauses);
3. Merger / Acquisition Activity;
4. Look Backs; and
5. Status of Shares Received

We will examine each of the potentially problematic areas in turn:

1. 'Capital' Distributions

We believe the most hazardous situation for convertible holders is often when a company distributes 'capital' to shareholders. If they are not compensated, convertible holders are disadvantaged in that any cash distribution will cause the share price to fall on an ex-date by the amount of that distribution. Hedged investors will also find themselves short the distribution without any corresponding compensation.

Normal dividends are the most common form of distribution (for which bond holders are not compensated), but for the most part these can be predicted and factored into theoretical models. The increasing trend towards share buy-backs (in the US at least), as opposed to special dividend payments, as a means of returning excess capital to shareholders, is therefore a very welcome development for the convertible markets. Buy backs conducted 'at market' leave the value of the shares unchanged (in theory) and do not disadvantage convertible bondholders.

However, other distributions such a Special Dividends, Bonus Share Issues, Bonus Warrants etc. will disadvantage convertible bondholders if there is no compensation.

To protect investors, the majority of indentures contain provisions stating that compensation must be offered if capital distributions are made to shareholders, other than in the form of 'normal' dividends. This compensation almost always comes via an adjustment to the conversion ratio, so that the bond will be convertible into more shares to leave the ex-date parity value unchanged.

Unfortunately, the definition of 'normal' dividends will often allow a company to distribute some amount of cash or securities, above and beyond its normal annual dividend, before convertible holders are compensated. In Europe and Asia, this amount is becoming standardised at between 3% and 5% (depending on the nature of the company and its dividend policy). In the US, it is more of a 'free-for-all'. The American Tower 5% 2010 USD, for example, rather generously (for the shareholders!) allows the issuer to pay a special dividend of up to 15% without compensating bondholders at all!

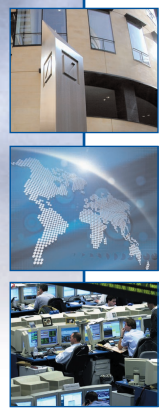
Non Cash Distributions

Where an issuer makes a distribution of non-cash securities (bonus shares, bonus warrants, debt securities, etc) the holder will be at the mercy of the indenture. There will usually be some compensation, but the way it will be calculated can vary considerably:

(i) Actual Ex-Rights Price - (i.e. compensation is based on where the stock trades when it goes ex-whatever the distribution is).

(ii) Theoretical Ex-Rights Price - (i.e. where the stock *ought* to trade based on the level of dilution and the 'price' at which the distribution is made).

The conversion ratio will always be adjusted to account for stock splits (i.e. if the stock is split in half, the conversion ratio is doubled etc).



2. Issuer Calls ('Screw Clauses')

'Screw' clauses state that convertible holders converting into shares will not be paid the accrued interest on their bonds by the issuer. This means that if a bond is callable an issuer can wait until just before a coupon is payable before calling the bond, forcing conversion, and 'screwing' investors out of their accrued interest. Unlike unforeseen and uncompensated distributions to shareholders, however, the market will warn investors of a likely 'screw' because callable 'in the money' convertibles subject to a 'screw' clause will trade at 'net parity'. Net parity means parity minus accrued interest (i.e. the price reflects the probable loss of accrued interest in the event of call and early conversion).

3. Merger / Acquisition Activity

In our view, probably the most treacherous area for convertible investors is M&A activity. When the conversion / exchange property (i.e. underlying equity) is acquired or merged with another entity, the overriding concern for convertible holders will be what the new conversion rights change to.

In virtually all jurisdictions, if a 'full legal merger' of two or more joint stock companies occurs, conversion rights will be protected and will be on-going into the new legal entity. But, in fact, full legal mergers in the strict sense are very rare, and the continuing legal existence of companies that have been 'merged' or 'acquired' can last indefinitely.

Under this latter scenario, there will be no automatic right of on-going conversion into the dominant company (in many countries), and investors will need to rely on remedies in the indenture and / or the goodwill of the acquiring / dominant company in order to determine their future rights.

It is much less clear what happens to conversion rights outside the (rare) full legal merger.

In some countries, notably Germany, it is not legally possible to bind an acquirer to honour conversion rights into an outstanding bond.

So in Europe a series of conventions have grown up to protect investors under change of control scenarios. In France and the Netherlands it is usual for an acquirer to allow continued conversion into the acquired shares. In the UK, however, it is more usual for investors to rely on remedies which offer an enhanced conversion window.

There are two main conventions for enhanced conversion windows:

(i) Step Conversion Clauses - They stipulate that, in a change of control, conversion is allowable at an enhanced ratio. This enhanced ratio falls as time goes by according to a schedule that is laid out at issue in the trust deed. On the announcement of a change of control, convertible holders will have a window of perhaps 60 days to convert at the prevailing enhanced ratio.

(ii) Average Premium Enhancement - is also used in the UK. This clause states that under a change of control the conversion ratio is enhanced according to the average premium of the bond over a given time period (often one year). Again the enhanced conversion window only applies for a specified time period (60 days is the norm).

Change of Control Puts

These state that the convertible will be puttable (usually at par / accreted value or just above) in the event of a change

of control. These provisions are very common everywhere, including the US. They obviously act as a poison put if parity is very low and the bonds are trading well below par.

What to watch out for!

(i) When is an Acquisition Not an Acquisition? The HypoVereins Bank / Bank Austria Precedent

We find it regrettable that some companies occasionally take steps that appear to avoid what was intended to protect investors who have bought convertibles in good faith.

In 2000, when the German HypoVereins Bank "acquired" Bank Austria, (the word "acquired" appeared in a Tombstone in the *Financial Times*, 16 November 2000), the deal was structured in such a way that the company was not obligated to honour a clause in the Bank Austria 0% 2004 EUR trust deed, which provided for compensation in the event that Bank Austria was acquired.

It is clear from this episode that the structure of any M&A activity is crucially important in determining what compensation will accrue to convertible investors.

(ii) Exchangeables

The treatment of exchangeables can differ from standard convertibles in M&A situations.

A particular problem can arise when non-equity securities are included as part of an acquisition of the company that forms the exchange property.

In this scenario, without express language to the contrary in the indenture, the conversion property can comprise cash, debt securities or other non-equity securities. This is fairly disastrous for the holder in that non-equity securities will usually have little or no (in the case of cash) volatility. Optionality is therefore worthless, and the exchangeable will collapse to intrinsic value.

Also note that the issuer of an exchangeable does not have to take account of the interests of exchangeable holders when deciding whether to accept (or what to accept) when an offer is made for the exchange property.

In order to address these concerns, indenture language has evolved (in Europe first of all) to require exchangeable issuers to use any cash received in an acquisition to purchase shares (or even index futures) to top-up the exchange property, thus preserving optionality and protecting the theoretical value of the exchangeable.

4. Look Backs

'Look back' clauses are often overlooked when convertibles are issued, but they can be nasty and virtually unhedgeable short options when a holder eventually comes to convert.

A 'look back' clause allows the issuer to decide whether to give a converting bond holder shares or the cash value of the shares. A problem arises where an issuer can choose to deliver cash or shares *after* the calculation period.

There is increasing evidence, certainly in the US, that issuers are opportunistic in exploiting these clauses, choosing between shares or cash on a 'cheapest to deliver' basis.

If the calculation period is very short (one day is not uncommon in the US) and the delivery / notice delay is a number of days later, investors can be badly disadvantaged if the share price is volatile.

XYZ Corp 5% 2006 USD has a look back option with a one day averaging period. Converting holders are told what they receive (cash or shares) two days after the conversion / reference date. XYZ Corp is a highly volatile stock, and as Table 29 shows, this disadvantages bond holders significantly if the company acts opportunistically.

For a hedged investor, a negative gamma position is created:

Table 29: The 'Look Back' in action

Scenario	Day 1 (reference date) Stock Price	Day 2 Stock Price	Day 3 (notice date) Stock Price	
A)	50.00	47.00	45.00	Company delivers stock
B)	50.00	52.00	55.00	Company delivers USD 50.00 per share

Source: Deutsche Bank Estimates

Scenario A: Hedge Bought Back

If the hedge (assumed 100%) is bought back at the time of conversion, this creates: 1) a long position in the stock only if the stock falls (i.e. stock will be delivered on Day 3 if it has fallen) or 2) a flat position if the stock goes up (USD 50.00 per share will be delivered).

Scenario B: Hedge Not Bought Back

However, if the hedge is retained until Day 3, cash will be delivered if the stock has risen to USD 55, and the investor will lose USD 5 per share buying back the hedge. Whereas if the stock falls, the position will only be flat as the delivered stock is used to close the short.

5. Status of Shares Received

Investors need to be aware of restrictions on stock delivered on conversion. Any restrictions should be highlighted in the indenture, but if in doubt, it may be necessary to check with the conversion agent (who is appointed by the issuer to handle the issuance of shares to converting bondholders).

The most common area of complication is dividend entitlement. In some countries in Europe, the shares delivered on conversion may not rank for the next dividend. In the Netherlands, part of the last coupon paid may even be repayable if the coupon accrual period overlaps a dividend entitlement period. In France, it is also common for shares delivered on conversion not to rank for dividends paid in the same financial year.

9. Convertibles for Issuers

Many different explanations have been put forward for why companies issue convertible securities. But what seems clear is that there is no all-embracing reason. Different structures can be used by different companies at different stages in their development.

As we demonstrate in Chapter 10, there are many different potential convertible structures, but they almost all have one thing in common: the issuer sells equity at a premium to its current price in return for giving an investor some kind of downside protection and / or extra yield.

The following corporate characteristics tend to tempt issuers into the convertibles market:

1. **Share price perceived to be too low for equity issuance;**

2. **Lack of good (any) credit rating makes straight debt expensive;**

3. **Non-strategic equity stake held in another company; and / or**

4. **Specific tax considerations.**

We will examine each in turn:

1. Share price perceived to be too low - A company that perceives its share price to be undervalued will not be keen to sell equity at prevailing levels. A convertible issue is one way of raising cash today whilst (potentially) selling equity at a price closer to the value ascribed to it by the company in the future. If the shares rise as the company expects, convertible holders will convert at maturity or before, effectively buying shares at the higher price that was originally judged appropriate by the issuer.

   Of course, if a company *knows* that its share price is going up then it should not issue any kind of equity, and should raise debt instead. But very few companies can realistically be in this position, and for most issuers convertibles offer a good way of selling equity forward at a more attractive price whilst raising cash immediately.

   There is also evidence that, as with other equity products, companies will act opportunistically and issue equity linked securities if they perceive their share price to be *too high*.

2. Lack of adequate credit rating - For many small or fast growing companies a straight debt issue is impossible because the lack of an investment grade rating leads to a prohibitive interest charge. By attaching an equity option, via a convertible, the company can reduce its interest expense dramatically.

3. Non-strategic equity stake held in another company - Exchangeable bonds have been extremely useful in Europe in helping to unwind corporate cross holdings.

Issuing an exchangeable bond allows a stake-holding company to:

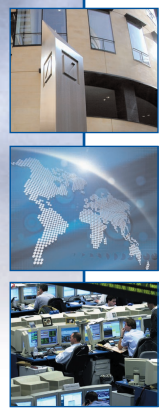
1) Dispose of the stake at a premium;

2) Retain economic control over the stake (retain voting rights etc.);

3) Delay crystallisation of any capital gains taxes; and

4) Finance at rates well below their normal funding cost.

Particularly for reason three, exchangeables proved especially popular in Germany in the late 1990s, ahead of a major reduction in disposal taxes.



4. Specific tax considerations - Tax considerations are always important in any capital raising exercise. It is probably not an exaggeration to say that convertible structures have been the subject of more ingenious tax engineering than almost any other form of financial security. Among the most important innovations in tax engineering are:

a) Capital Gains Tax Deferral - Exchangeable bonds allow the (potential) forward sale of a stake without crystallising the tax liability until the bonds are actually converted. In fact, exchangeable bonds usually include the option for the company to deliver cash instead of shares, thus giving the issuer even more flexibility to manage disposal tax liabilities.

b) MIPS Structures - Although this structure has now been closed off, MIPS provided a very important funding vehicle in the mid 1990s in the US. A special purpose vehicle was set up between the issuer and the investor, allowing a company to issue mandatory securities (which ranked as equity on the balance sheet), but then to claim tax deductibility on the interest payments.

c) Contingent Payment and Conversion - *The* innovation for the early 2000s (in the US at least) is certainly contingent conversion and payment features being added to long dated bonds issued by investment grade companies. These issues give the issuer significantly improved dilution / tax treatment. 'CoCo' and 'CoPay' are explained fully in Chapter 10 'Convertible Structures'.

An Issuance Scenario

XYZ Corp 5% 2006 USD is a fast growing technology company. The company needs to increase working capital in order to increase productive capacity. Management believes that the market is not fully valuing the potential growth rate of the company, and that the shares are undervalued by around 25%.

If the company were to issue straight debt in US Dollars, it is advised that a YTM/P of USD LIBOR + 500 bps would be necessary. The company does not have enough free cash to meet such high interest payments.

A convertible bond issue may be a good solution to XYZ Corp's financing needs. The company could raise USD 100 to USD 300m for five years at a YTM of perhaps USD LIBOR flat if the conversion premium was set at around 25%.

If the shares rally as the company expects, it will have sold its equity forward for the price it originally wanted, whilst delaying dilution for up to 5 years. If the shares do not perform, the company will at least have saved 500 bps a year in yield versus a straight bond issue.

Exercising Issuer Calls

The most important decision a company will have to make after it has issued a convertible is when, or whether, to exercise its call option (if it has one). We discussed 'provisional' and 'hard' call protection in Chapter 2, and we now revisit these call features from the issuer's point of view.

Provisionally Callable Convertibles - We assume that the objective of all convertible issuers is to get their securities converted into shares either at maturity or before. When a bond is provisionally callable with a trigger at (say) 140% of conversion price, it is a fairly straightforward decision for the issuer whether or not to call if the shares trade above this level. If the dividend yield on the shares is less than the coupon on the convertible (after adjusting for tax), it will usually be in the company's interests to call and force conversion.

The company will have to give notice of its intention to redeem the bond (normally at least 30 days), giving investors the opportunity to convert. If parity > 140 there is little danger of parity slipping below 100 and the company having to find cash to pay bondholders the redemption amount. It will almost always be advantageous for a company to call a convertible just before a coupon payment date if the bond has a 'screw' clause.

Hard Calls - When a bond is absolutely callable the same considerations as above apply, but the difficulty occurs if parity is above 100 (redemption value), but not by a sufficient margin to preclude the possibility that it might fall below 100 during the conversion period. In this situation the company has a problem. If parity is not sufficiently above redemption value, parity might drop below redemption value, forcing the company to redeem the securities for cash instead. It is also in the investors' interest to wait until the end of the conversion period before deciding what to do, thus maximising the 'put' value of the convertible.

In practice, issuers often build a 'call cushion' into their call assessment. This is usually around 10% above the redemption amount, depending on the volatility of the stock.

Buying Convertibles Back

If a company judges its convertibles to be undervalued in the market, it may choose to buy them back. But this scenario is dependent on the existing convertibles not being fully valued by convertible investors.

The New Issue Process: A Typical Convertible Deal

Opposite we sketch a slightly stylised, but broadly realistic, new issuance scenario for a book built transaction.

Launch Date: - 1 month (or more)

Officials from the potential issuer listen to 'pitches' from investment banks regarding the many different structures / pricing that could meet their financing / disposal requirements. The basic size and structure of the issue takes shape. The company reaches tentative conclusions on the structure and target pricing for the premium and YTM/P.

Launch Date: - 2 weeks

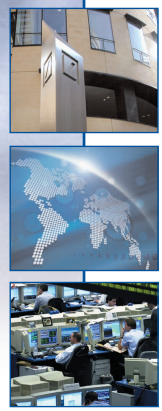
A leading convertibles investment bank is mandated to manage the sale. The company decides the minimum it would like to raise is EUR 1 billion, but grants the lead manager an option to sell another EUR 200 million of the bonds if demand is strong (the 'greenshoe' option). A target date is set to launch the transaction, but market conditions will play the most important role, and the issuer's stock price will be crucially important in determining the launch date.

Launch Date: - 1 week

Legal work on documentation, drafting the preliminary prospectus and discussions with relevant regulators or exchanges is well advanced. Officials from the company and the bank are now watching the company's stock price, the bond market and the level of valuations in the convertible market very closely, searching for exactly the right moment to launch the transaction.

Launch Date: - 1 day

The issuer and bank meet after the close and agree to launch the transaction at 7:00 am the next day. The exact pricing range is agreed, consisting of 50 bps spread on the YTM and 5 percentage points of premium range. Relevant regulators and / or exchange officials are notified, and senior



salespeople from the investment bank are briefed on the forthcoming sale.

Launch Date: 7:00am

Deal launched!! The lead manager plus other members of syndicate begin calling convertible investors and the book building process starts. A three day book building process is envisioned, with the company's management touring investor centres on a 'roadshow' of presentations.

Launch Date: + 2 days (pm)

The 'book' of demand for the bond now exceeds EUR 6 billion, consisting of mainly non-limited orders. The bonds are quoted 101.00 - 101.50 in the 'grey' (pre-issue) market. The stock came under a small amount of pressure on Day 1 of the marketing period, but has since recovered. Management and bank officials, who have been in constant contact, meet and decide to close the book early and to increase the issue size to EUR 1.25 billion. A 'pricing call' is held and the final terms of the convertible are agreed between the investment bank and the company. Pricing is towards the low end of the yield range and the high end of the premium range, to reflect the level of demand. The two sides go through the 'book' and decide how to 'allocate' the securities.

Launch Date: + 3 days (am)

Subscribers are informed of their allocations and, only once this process is completed, bonds begin formal trading.

After the Issue

Many things happen after the first day of trading. Bonds become listed on exchanges, 'season' to allow initially exempt investors to purchase them and are included in the market making universe of the lending convertible brokers. Importantly, the bank may elect to exercise the 'greenshoe' option to create extra securities to meet excessive demand.

10. Convertible Structures

Unfortunately for the newcomer, convertible structures continue to become more complex and innovative. In this section we discuss the main types of convertible structure and consider the valuation issues associated with them.

Zero Coupon Convertibles

Zero Coupon convertibles pay no coupon and have a current yield of 0%. Yield to maturity or put (YTM/P) is achieved by means of an issue price below final redemption value and / or put values (i.e. investors pay 60 today for a bond maturing in five years at 100 - giving a YTM of around 10.5%). The bonds are sometimes called Original Issue Discount (OID) bonds.

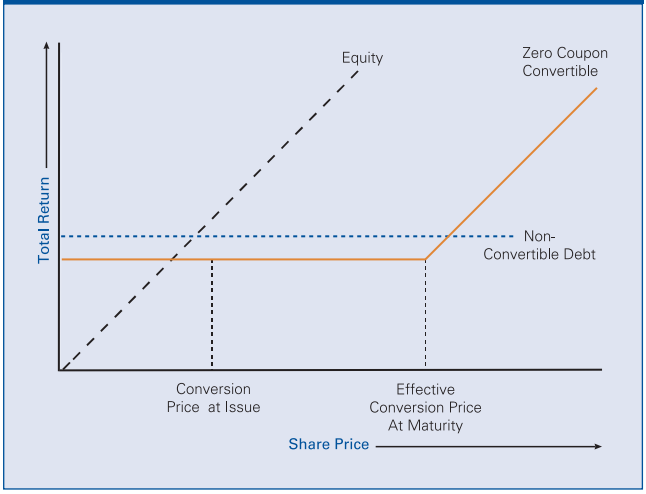
Roche 0% 2010 USD is a good example of this structure. The bond was issued at 35.628 on 20 April 1995 and redeems at par (100) in 2010, giving a YTM of 7% at issue. The bond also has puts every five years at accreted value.

Calls and puts on 'zeros' are calculated according to 'accreted value'. Accreted value is the price that keeps YTM constant. Roche 0% 2010 USD is callable on 20 April 2003 at 61.778 (accreted value). This is the value the bond will have 'accreted' to in 2003 in order to keep YTM constant at 7%.

Zero coupon bonds have a much higher effective conversion price at maturity than couponed bonds, and as such have lower deltas and more defensive characteristics. They tend to be issued by higher credit quality companies.

The 'payoff' diagram (Figure 44) shows that the return on the bond remains constant unless the share price rises a long way during the life of the bond. The difference between the conversion price based on the issue price and the conversion price based on the final redemption price is the disadvantage (from an investor's point of view) inherent in zeros.

Fig 44: Zero Coupon Convertible - Defensive Security



Source: Deutsche Bank Estimates

Zero coupon bonds received a huge new lease of life in the US in 2000 as a result of the 'CoCo / 'CoPay' revolution, which we discuss below.

Knock-Out Puts

Some issues employ knock-out puts, where the put lapses if the share price trades above a pre-determined level (the 'knock-out level') at any time before the put. The knock-out level is usually set at 130% to 140% of the conversion price.

Bond with Warrants

Bonds are sometimes issued with attached warrants. Where the warrants are detachable from the bond and exercisable for cash, they are stripped in the market and trade separately.

Bonds can also be issued with 'non-detachable warrants', where the warrants can only be exercised by tendering the whole bond. The 'bond with warrant' structure can be useful in specific circumstances. It can help with pre-emption rights problems and can limit withholding tax liabilities for investors. An example is the Daimler Benz 4.125% 2003 DEM N.E.W.S. ("Notes with Equity Warrant Securities"). Such structures behave as if they were plain vanilla convertibles.

Mandatory Structures

In the US in the 1990s, the falling dividend yield on ordinary shares led to the creation of a whole new class of mandatorily convertible instruments. The rationale behind these structures was to give equity income investors greater yield in exchange for slightly muted upside participation. Because these preference shares mandatorily convert into ordinary shares at maturity, there is no danger of the issuer having to find cash to redeem them. From this simple idea has grown a bewildering array of mandatory securities (with ever sillier associated acronyms). But all share the same basic idea of the investor receiving enhanced dividend income in return for slightly reduced equity upside participation.

The key to understanding mandatory structures is that the conversion ratio will change depending on the price of the shares at maturity. This means that if the share price rises, within certain bands, the conversion ratio will fall. This reduces an investor's upside participation.

From an issuer's point of view, the structure will be attractive if the shares rise, because investors will be buying equity at a premium. There are two main 'families' of mandatory security:

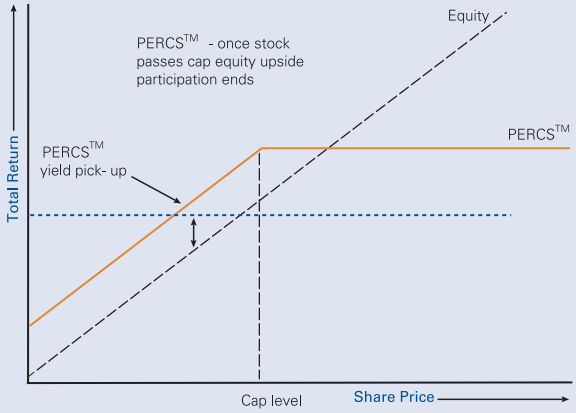
1) PERCS™ ; and

2) DECS™

Note that almost all mandatory structures are European style options.

1) PERCS™ are very simple securities. They are usually issued at the prevailing share price, convertible into one ordinary share, with an enhanced dividend yield. Above a certain stock price, however, the conversion ratio will fall by the amount the stock rises, capping the upside at that level. PERCS™ are convertible 1:1 below this cap level, which means that they participate 100% on the downside. PERCS™ have a payoff structure as shown in Figure 45.

Fig 45: PERCS™ are Fairly Defensive Instruments



Source: Deutsche Bank Estimates

In option terms, a PERCS™ investor is:

1. **Long stock;**

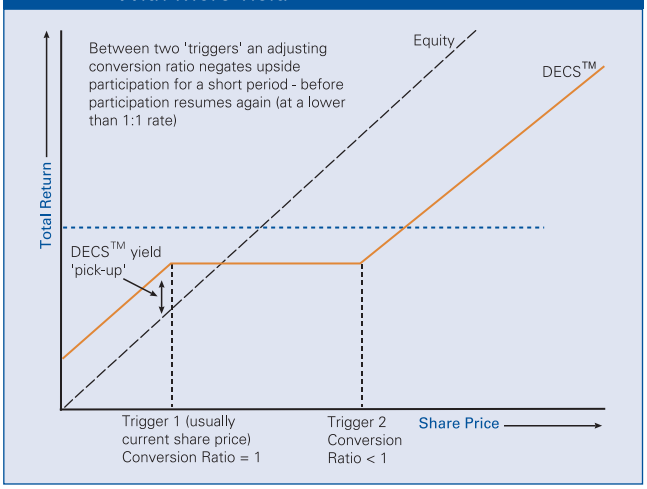
2. **Short 1 European call struck at 'cap level'; and**

3. **Long income swap of PERCS™ dividends for ordinary dividends**

Investors modelling PERCS™ need only calculate the price of the call they are short (struck at 'cap' level) and compare that with the present value of the PERCS™ income advantage. PERCS™ are generally issued by companies that are bullish on their own share price.

2) DECS™ are a little more complicated than PERCS™, and are more equity-like. Instead of upside participation ending completely above the cap level, DECS™ employ a 'dead zone' of no equity participation, but offer holders renewed upside above a higher trigger. DECS™ are also usually issued at the prevailing share price with an initial conversion ratio of 1:1. The total return is shown in Figure 46.

Fig 46: DECS™ Give Upside and Downside Participation - With More Yield



Source: Deutsche Bank Estimates

The DECS™ investor gives up upside in return for enhanced yield. Between Trigger 1 and Trigger 2, the conversion ratio falls as the share price rises to keep the total return constant between these stock prices. Above Trigger 2, the conversion ratio is again constant, but at a lower level than Trigger 1, so (unlike the PERCS™), the DECS™ participates again in further equity upside. Because of their greater upside participation, DECS™ will typically have a yield advantage below that of a similar PERCS™.

Valuing a DECS™

Holding a DECS™, an investor is:

1. **Long 0.xx European calls at upper trigger level (Number of calls = Initial Stock Price / Trigger 2)**
2. **Short 1 European put at Trigger 1 level**
3. **Long risk-free 0% bond paying initial stock price at maturity**
4. **Long PV of risky dividend payments**

The key to valuing a DECS™ is to get the skew right between the valuation of the call and the put.

Both options have the same maturity and European style, but the different strike prices require the prevailing term structure of OTC volatility to be applied.

Convertible Preferreds

In the US market, a large number of convertibles are structured as convertible preference shares. These 'prefs' often have a nominal value of USD 50.

There are a number of differences between convertible preference shares and standard convertibles bonds:

1. Redemption: 'Prefs' can be redeemable or irredeemable. If irredeemable, the market convention is to treat them

as 50 year redeemable structures.

2. Denomination: Usually USD 50 par amount.
3. Listing: Often listed on an equity exchange (NYSE).
4. Dividends: Usually paid quarterly.
5. Ranking: Usually subordinate to all debt obligations.
6. Trading: Trade 'dirty' (inclusive of accrued interest).

Other than the above, there is no reason why convertible preferreds will not trade as normal convertible instruments.

Parity Resets

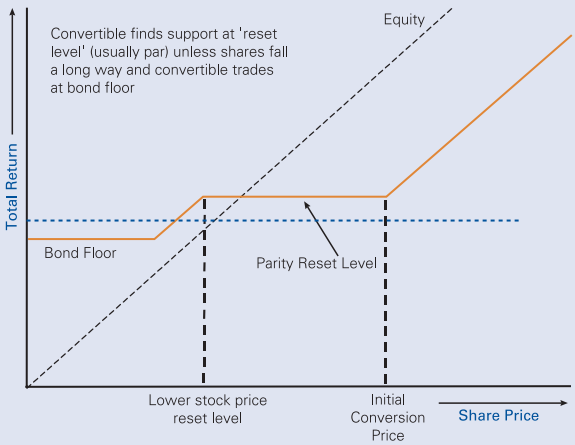
In our view, one of the most interesting developments in the convertible market in the mid 1990s was the introduction of 'parity resets' clauses. Resets mean that on certain dates the conversion price is reset to a level at (or near) the prevailing share price (i.e. - if the shares fall you get more of them per bond to make up for the fact that they are worth less).

We believe parity resets are very attractive for investors. They are effectively puts payable in stock at par. However, parity refixes always have a maximum limit on the amount of the conversion ratio adjustment. Usually, this means that the conversion price can be adjusted down to a certain minimum, such as 60% of the initial conversion price at issue.

The payoff for a parity reset convertible bond is shown in Figure 47.

Many of the Japanese resettable securities issued in the 1990s were mandatory preferreds rather than bonds. Investors can get a reasonable approximation of the value of mandatory preferreds with resets by valuing them as European options to the next reset date only.

Fig 47: 'Parity Refix' Convertible Payoff



Source: Deutsche Bank Estimates

They are then worth the sum of:

1. **The present value of the reset amount (usually Nominal Value)**

Minus (-)

2. **Puts struck at the Lowest Conversion Price =**

$$\frac{\text{Nominal Value}}{\text{Lowest Convertible Price}}$$

Plus (+)

3. **Calls struck at the Initial Conversion Price =**

$$\frac{\text{Nominal Value}}{\text{Initial Convertible Price}}$$

Modelling a Parity Reset Bond is More Difficult

Modelling a parity reset bond, as opposed to mandatory preferred, is more difficult, because although the investor is still short the puts, downside is limited by the fixed income value of the convertible. In effect, the investor is only short a put between the reset amount (par) and the bond floor.

Monte Carlo Simulation

The most accurate method for valuing path dependent derivatives such as parity reset convertibles is Monte Carlo simulation. This can be done in a spreadsheet using the following methodology:

1. Set up a spreadsheet using Excel and take a univariate standardised normal distribution as described in John C. Hull's *Options, Futures and Other Derivatives* (p. 218).

   The mean should be the expected annualised return on the stock and the standard deviation should be the expected volatility over the full life of the security.

2. Create all the days between the current (or valuation) date and maturity and apply the normal distribution to calculate the movements in the stock price.

3. At the reset dates apply an "IF" function to reset the conversion ratio to the appropriate number.

Step-Up Coupon Convertibles

A step-up coupon convertible has a coupon which is increased on set dates during the life of the instrument. YTM can still be calculated without any difficulty at issue, as all fixed income flows are known in advance.

Cross Currency Convertibles

Cross currency convertibles are those in which the bond is denominated in a different currency from that of the underlying stock. This means that investors have currency exposure because parity on a cross currency convertible is:

(stock price x conversion ratio) / FX in local currency

This formula means that if the currency of the underlying stock weakens, parity will fall even if the stock price remains unchanged. When the underlying stock is an exporter this effect may be mitigated somewhat by an appreciation in the share price accompanying a decline in the currency. Parity volatility (as opposed to stock volatility) will be lower and the theoretical value of the convertible will be depressed accordingly.

Investors can project this effect by regressing the share price against the local currency in terms of the bond currency. The correlation can be used to calculate parity volatility as follows:

Parity Volatility:

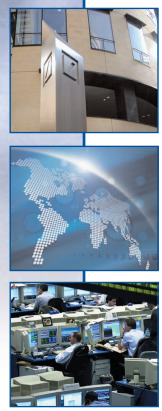
$$\sqrt{(\text{Stk. Vol.}^2 + \text{FX Vol.}^2) - 2(\text{Stk. Vol. x FX Vol.})(\text{Corr.})}$$

Alternatively, investors can calculate the stock's volatility in the currency of the bond. This will take into account the correlation.

This value is then used in the binomial model as the volatility assumption for the cross currency convertible.

Contingent Conversion Convertibles ('CoCos')

'CoCo' structures came to the fore amongst investment grade issuers in the US in 2000. The innovation is very



simple. The bonds do not become convertible unless the stock trades above a trigger level, usually expressed in relation to the conversion price (110% is common).

In order to protect investors, the bonds will become automatically convertible under most M&A scenarios, or if any qualifying capital distributions are made. Conversion is automatically allowable if the bonds are called.

Because the zone of non-performance is small (between 100% and 110%), projected far out into the future (many CoCos are structured as 20 year obligations) and early exercise is rarely optimal, the loss of theoretical value is small.

However, investors should be concerned about the need to convert a bond in order to participate in an unforeseen and uncompensated corporate action event.

The CoCo structure (especially when combined with a CoPay feature) significantly increases the attractiveness of the convertible asset class to the issuer, because although proceeds are taken in immediately, the dilution of the new shares does not have to be accounted for until the contingent conversion threshold is satisfied.

Contingent Payment Convertibles ('CoPays')

'CoPay' features are often used alongside the CoCo structure, although they are separate features and can be used independently. Contingent payment features are much more varied than CoCo structures, but all have characteristics which allow them to be classified under the US IRS's Contingent Payment Debt Instrument (CPDI) regulations. Such classification allows the issuer to claim deductions based on the *non*-convertible cost of debt (which will usually be stated in the indenture). This can be very significant. The D.R. Horton 0% 2021 USD convertible had an initial YTM/P of 3.25%, whereas the company stated in the indenture that its comparable non-convertible yield would be 8.88%. This provides a very sizeable current tax shield.

In addition, if the bonds are converted, the difference between parity at the time of conversion and the accreted value of the comparable non-convertible bond (less any coupons) can also usually be used as as tax shield.

The downside risk for investors is that the difference between the convertible and non-convertible yields may result in 'phantom income' to non US Federal income tax exempt investors. For this reason, these securities have been marketed more towards tax exempt offshore funds (particularly hedge funds).

'Phones' and 'Zones'

These securities also include contingent payment features, where the issuer can voluntarily make payments on the bond during its life and have this amount deducted from the principal due at maturity.

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