
Analysing some exotic options: EDS, instalments shares

1. INTRODUCTION

1.1 General properties

New varieties of equity derivative products have increased in popularity and market share over the past few years. One of the main motivations for writing this paper has been the lack of academic papers on the topic.

The products we want to investigate go under different names such as Enhanced Dividend Securities (EDS), HotEDS, Share Instalments, Darts and Property Plus, and are all of a specific type of exotic call option. The EDS, HotEDS and Property Plus instruments are issued by Investec; instalment shares are offered by ABSA, Nedbank, Standard Bank and Deutsche Bank; and all are traded on the JSE (full details are given in the web pages of the organizations: see the reference list).

These products give holders

- the right to buy the underlying share at a pre-determined (strike) price on or before an expiry date
- equivalently, the right to buy the underlying share in two pre-determined instalments – an initial payment and a final (strike) payment on or before an expiry date
- the right to the dividends on the underlying for only partial payment on that share
- the possibility of a cash settlement instead of paying the outstanding instalment should the option not be exercised
- the possibility of selling the instrument before expiry or rolling it over at expiry.

The EDS-type also features a barrier which can be seen as a stop-loss protection. There is namely a guaranteed rebate if the share price falls below a certain level.

In all cases the price of the option at issue (first instalment) is usually about 55% to 60% of the then share price, with the strike (second instalment) set at

50% of the initial share price. The extra 5% – 10% represents the interest paid upfront to the issuer for the “loan” of the amount of the second instalment. The loan period is the time t from issue to exercise or expiry of the option. HotEDS operate on a strike of 75% of the initial share price and a premium of about 30% upfront (Swain, 2006).

Property Plus is a derivative instrument providing gearing in case of a rebound in listed property stocks. It operates in the same way as the EDS, but with a non-constant strike price. The strike is adjusted daily by recalculating forward rate expectations and it can also be reduced if dividends are paid by the company.

All these derivative products give holders enhanced or geared dividend yields, the opportunity to buy the share in instalments, and conservative gearing to share price movements. They are considered to be less risky than warrants or share futures. The South African market in enhanced dividend securities has grown to trades of up to R20 million a day, rivalling the market in warrants at R30 million a day (Business Report February 2006). EDS and instalment shares appear to have become very popular with a lot of attention given by the media (FinWeek, Business Report and others). Reports have however changed from a very positive and bullish view in early 2006 to an announcement (FinWeek, 22 June 2006) that nearly all 120 instalment shares were “under the water”. De Klerk (FinWeek, 19 October 2006) comments that share instalments are “dangerous” and on 21 June 2007 he writes (FinWeek): “Keep away from all instalment shares – in other words, buying shares on credit – as long as interest rates are rising.”

In the light of the above remarks and reports, an investigation into the mechanics of these exotic options is a valuable and interesting exercise. We will concentrate on EDS and share instalment securities and present a simple mathematical analysis of the properties of these options. We ignore the effect of transaction costs.

1.2 Example of a barrier EDS option with rebate

In 2005 Investec issued an EDS on African Bank with the following properties (prices in cents):

Price of option at issue: $C(0) = 743$

Share price at issue: $S(0) = 1350$

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Strike (exercise) price: $K = 675$

Barrier level: $L = 945$

Maturity: $T = 1$ year (For our analysis we set time of issue as $t = 0$.)

In this example we have $K = 0,5 S(0)$ and $L = 0,7 S(0)$.

The option is issued deep-in-the-money with immediate intrinsic value $S(0) - K = 675$.

We have the relation

$$C(0) = 0,5 S(0) + 0,1(0,5 S(0)) \quad (\text{in this example } 743 = 0,5(1350) + 0,1(675)), \quad \text{or}$$

$$C(0) = (S(0) - K) + 0,1(S(0) - K).$$

The time value at issue is thus only 68. This is typical of deep-in-the-money options.

Seen as an instalment share with instalments $C(0)$ and K , we can also express the price of the option as $C(0) = 0,5 S(0) + 0,1 K$, i.e. the price of the EDS or first instalment is half the share price plus interest, paid upfront, of 10% on the outstanding amount $K (=0,5 S(0))$.

The gearing is almost two: $S(0) / C(0) \approx 1,82$. This is also the dividend gearing (see equation (4a) later on).

The share price $S(t)$ and option value $C(t)$ then evolve over time $t > 0$. The gearing is maintained since deep-in-the-money options track the share price on a nearly 1–1 basis (see Section 3).

If the underlying share price $S(t)$ hits the barrier at some time $t = \tau$, then the EDS terminates and the holder receives the intrinsic value of the option. In this case it would be $S(\tau) - K \approx L - K = 0,20 S(0) = 270$.

There is a loss, limited to 473 cents or 64% of the premium. But note that holding the share itself would have meant a loss at $t = \tau$ of only 405 cents or a 30% loss with the investor still owning the share.

If the option (EDS) is exercised at some time t , the holder will pay amount K to receive a share valued at $S(t)$. At maturity, the option can be exercised, settled in cash to the value $S(T) - K$, or rolled over. In the latter case, the intrinsic value $S(T) - K$ would have to be big enough to cover the price $C^*(0)$ of the new issue of the EDS on that particular share.

Between $t = 0$ and time of exercise or termination of the EDS, the holder receives all dividends (if any).

Possible scenarios at time t , $0 < t \leq T$, are illustrated in Table 1. We compare the cases of buying and exercising the option versus holding the share itself. As the barrier is approached, losses on the option increase. At the time of the analysis the risk-free rate was about 9%.

Selling the option instead of exercising is another possibility that we consider later.

If dividends with time- t value of say 50 cents are included, the option profits will increase by about 6,7% and those of the share by about 3,7%.

At $t = T$, roll-over would be possible only if

$$S(T) - K > 0,5 S(T) + 0,1(0,5 S(T)),$$

assuming that an interest rate of 10% will again apply to the loan of the new second instalment. Hence roll-over is possible in this case only if $S(T) > 1500$; in the case where rising interest rates indicate an interest rate of say 12% on the new loan we will need

$S(T) > 1534$. Rising interest rates however can mean that share prices are slow to increase.

Table 1: Profit or loss when exercising the EDS versus owning share at time t

Share price (cents) at t	Action taken	% option profit $(S(t) - K - C(0)) / C(0) \times 100$	% share profit $(S(t) - S(0)) / S(0) \times 100$
2000	Exercise option	78,3%	48,1%
1800	Exercise option	51,4%	33,3%
1600	Exercise option	25%	18,5%
1500	Exercise option	11%	11%
1450	Exercise option	4,3%	7,4%
1000	Exercise option	-56%	-26%
945	Accept rebate	-64%	-30%

2. GENERAL ANALYSIS

The analysis is based on approximate and illustrative values, but serves to show the effect that interest rates, share prices, barriers and so on can have on the profitability of instalment shares.

In general an EDS can be seen as an American down-and-out call option on a share with price $S(t)$. The option has a barrier L , strike K and maturity $T=1$ year. The option is bought at time $t=0$ when the share price is $S(0)$. The initial option price is $C(0)$.

$C(0)$ can be interpreted as the first instalment and K as the second instalment for buying the underlying share. For this analysis we set $K = 0,5 S(0)$. This is a typical value.

We write

$$C(0) = 0,5 S(0) + \delta, \quad \dots (1)$$

where

δ is the amount of interest payable upfront for the "loan" of amount K . The amount δ can be expressed as a percentage of K and for this analysis (based on 2005 data) will be approximately 10% of K or 5% of $S(0)$. Rising interest rate scenarios will mean higher rates.

As deep-in-the-money options, EDSs directly track the performance of the underlying share: a change in the share price $S(t)$ is accompanied by a change in options price $C(t)$ on a near 1-1 basis. This will be shown in Section 3.

2.1 The effect of the barrier with rebate

If a barrier is present (see Investec-issued securities), this is often seen as a feature which limits potential losses by the holder. When the barrier is hit, the option knocks out and a rebate is offered. However, as we will see in equation (2) below, this rebate is always less than the price paid and there is thus always a loss when the barrier is hit.

Should S fall even further, the holder is protected against further losses, but at the same time cannot take advantage if S rises above L at a later stage. Knock-out seems to be the worst scenario for the option holder.

Barrier options are usually cheaper than comparable vanilla options because the option may expire worthless before maturity and before potential recovery of share prices (Higham, 2004). In our case there is a rebate which would make the option more expensive than a barrier without rebate.

A typical value for the barrier level of an EDS is

$$L = 0,75 S(0).$$

If the underlying share price $S(t)$ hits the barrier at some time $t = \tau$, then the holder receives the intrinsic value of the option. The time value of the option is forfeited.

Approximating $S(\tau)$ by L , we have

$$\begin{aligned} \text{payoff (intrinsic value)} &= S(\tau) - K \\ &\approx L - K = 0,25 S(0). \end{aligned}$$

The "gain" to the holder is

$$0,25 S(0) - C(0) \quad \dots (2)$$

which is of course a loss, since $C(0) > 0,5 S(0)$.

So, if the share price drops by 25% of its initial value, the option expires and a rebate is paid. In effect you will have paid $S(0) + \delta$ to receive the value of the share at that point, that is $L (= 0,75 S(0))$. Your return is about -55%. Knock-out seems to be the worst scenario for the option holder. (If the barrier is hit after dividends have been paid the holder of the option loses slightly less.)

In the case of an extreme and sustained drop in share price it is true that the holder is potentially better off with the barrier option than with an option without barrier. In the latter case there is a 100% loss at T if $S(T) < K$, in the former the loss is about 55% at T if $S(\tau) < L$. This assumes there is no attempt by the investor to exercise or sell the option earlier. All-in-all though, one has to question the advantage of holding an expensive barrier option with rebate.

The probability of the share price hitting the barrier at a typical value of $L = 0,75 S(0)$ can be estimated.

Assuming a log-normal distribution for the share price $S(t)$, an annual expected return of μ and volatility of return σ , we have (Hull 2002):

$$\ln S(t) \sim N\left[\ln S(0) + (\mu - \frac{1}{2}\sigma^2)t; \sigma\sqrt{t}\right].$$

The notation $X \sim N[m;s]$ denotes that random variable X is normally distributed with mean m and standard deviation s .

The probability of going through the barrier at some time t , namely $P(S(t) \leq L)$, can be calculated:

$$\begin{aligned}
 P(S(t) \leq L) &= P(\ln S(t) \leq \ln L) \\
 &= P\left(\left\{\frac{\ln S(t) - \left[\ln S(0) + \left(\mu - \frac{1}{2}\sigma^2\right)t\right]}{\sigma\sqrt{t}}\right\} < \left\{\frac{\ln L - \left[\ln S(0) + \left(\mu - \frac{1}{2}\sigma^2\right)t\right]}{\sigma\sqrt{t}}\right\}\right) \\
 &= P(Z(t) \leq -0,77) \text{ for illustrative values of } \mu=0,1; \sigma=0,4; t=1. \\
 &= \Phi(-0,77) \\
 &= 0,22
 \end{aligned}$$

(Φ denotes the cumulative probability for the standardised normal distribution Z).

Thus in this case we have a 22% probability of going through the barrier towards the end of the year. For $\sigma = 0,6$, we have $\Phi(-0,35) \approx 0,363$.

For volatilities of between 40% and 60% we thus see that the probability of going through the barrier at the end of the year is roughly between 22% and 36% respectively.

At $t = 0,5$ (mid-way through the life of the option) the probabilities are between 15% and 28%.

For HotEDS, the strike is set at $K = 0,75 S(0)$ and the barrier is set at about $0,85 S(0)$. The price of the option is $C(0) = 0,25 S(0) + \delta$ with a typical value for δ of 5% of $S(0)$ (Swain, 2006). In this case the payoff when the barrier is hit is, $L - K = 0,1 S(0)$. The loss is about 67%.

2.2 Exercising the option in the absence of a barrier

If no barrier is present (e.g. ABSA, Nedbank, Standard Bank issued options), the option can be exercised at any time up to $T = 1$. If there is no barrier, it is never optimal to exercise this type of option early. If however $S(T) < K$ the option expires worthless. Your loss is then 100% and the option cannot be rolled over.

Suppose the option is exercised at time t^* , and the shares received in return for payment K .

The payoff in this case is:

$$S(t^*) - K, \quad \dots (3)$$

and the gain (profit/loss) to the holder is:

$$S(t^*) - K - C(0) \approx S(t^*) - S(0) - \delta.$$

From this it follows that a profit is made by buying the share in instalments only if at some time t^* we have $S(t^*) > S(0) + \delta$,

that is, only if

$$S(t^*) > S(0)[1 + 0,05]. \text{ (Assuming } \delta=0,05 S(0).)$$

This means a 5% increase in share price is needed for a profit. The percentage gain, defined as $[S(t^*) - K - C(0)] / C(0)$, will then be about

$$1,81[S(t^*)/S(0)] - 1,91.$$

Compare this with the case of owning the share where a profit is made if $S(t^*) > S(0)$ and the percentage profit is $[S(t^*) / S(0)] - 1$.

The return on owning the EDS is larger than that of owning the share if

$$S(t^*) > 1,1235 S(0).$$

This means a 12,35% increase in share price is needed for the instalment option to become more profitable than holding the share itself. However, buying the option does require a smaller outlay than buying the share.

Irrespective of when you exercise the option you will have paid $S(0) + \delta$ for the share, ignoring time value of money. It will be better to exercise after you have received dividends. As with American options on shares with no dividends, early exercise does not seem to be advisable.

If the option ends in the money and is not exercised, a cash settlement of $S(T) - K$ is made.

Note 1: $S(T)$ actually refers to the 2-day simple average of the daily volume weighted average price. We shall simply denote all share prices by $S(t)$, $0 \leq t \leq T$.

Note 2: If there is in fact a barrier in place early exercise may be advisable when the share price is heading for the barrier. The option is still deep-in-the-money at this stage and may be worth exercising.

2.3 Selling the option instead of exercising

If the object is to speculate and not to acquire the share, it may be better to sell the option before maturity. The option can be sold at any time with the market maker providing a bid/offer spread. The theoretical (fair) price of the option will be discussed in Section 3. Transaction costs and the size of the market maker's spread will determine the profitability of selling the option.

2.4 Dividend gearing and price gearing

Dividends: The holder of the option receives the dividends on the underlying share.

This is a fairly special feature because normal vanilla options do not entitle the holder to dividends. Such vanilla options on shares with dividends are less expensive than options on shares without dividends (Higham, 2004). This is because for shares, without dividends, there is no drop in share price on ex-dividend dates with a resulting drop in option value. In the case of the EDS the property of receiving the dividends should now make the option slightly more expensive than the vanilla option on shares with dividends.

Since options are cheaper than the underlying share itself, the EDS option offers geared dividend yields with respect to the share. If the expected annual dividend amount is denoted by d , the dividend yields are $d/C(0)$ and $d/S(0)$ respectively so that the dividend gearing is:

$$\text{divg} = \{d / C(0)\} / \{d / S(0)\} = S(0) / C(0) \quad \dots (4a)$$

Since $C(0) = 0,5 S(0) + \delta$; the dividend gearing can be expressed as

$$\text{divg} = 2 - [2\delta / (0,5 S(0) + \delta)]. \quad \dots (4b)$$

This is just less than 2, depending on the interest δ you are required to pay. As δ increases, the divg decreases. For divg to approach 2 the interest will have to approach zero.

Equation (4b) shows the relationship between the dividend gearing and interest set by the writing company. For a dividend gearing of 1,82 we find $\delta = 0,05 S(0) = 0,10 [S(0)/2]$.

This implies an interest rate of 10% on the loan amount. If the loan interest is 20% the gearing drops to 1,67. (The HotEDS has a higher dividend gearing: about 3,3.)

Price gearing for EDS: The dividend gearing is also the gearing between prices S and C . In fact, the the gearing, defined as the ratio of

$[C(t) - C(0)] / C(0)$ to $[S(t) - S(0)] / S(0)$, or $\Delta C / C(0)$ to $\Delta S / S(0)$; simplifies to

$$S(0)/C(0)[\Delta C/\Delta S].$$

Since $[\Delta C/\Delta S]$ relates to the delta of the option and we see later that this is approximately 1, the gearing remains close to $S(0)/C(0)$. This is just the dividend

gearing divg as shown in the equation (4a). We know that this is just less than 2, typically 1,82.

2.5 Borrowing from the issuer versus borrowing from the bank

Assume we have the amount $C(0)$. Let us write the interest amount δ paid to the writer of the option as $f K$ or $f S(0)/2$ where f represents a fixed rate (decimal), irrespective of the loan period.

$$\text{Thus } C(0) = 0,5 S(0)[1 + f].$$

If you can exercise the option at maturity (1 year), you pay the amount K and own the share. The future value of your payments at maturity is

$$\begin{aligned} FV &= C(0)[1 + r_d] + K \\ &= 0,5 S(0)[1 + f][1 + r_d] + 0,5 S(0) \end{aligned}$$

where

r_d is the annual discount rate.

This can be written:

$$FV = S(0) + 0,5 S(0)[f + r_d + fr_d] \quad \dots (5)$$

Alternatively, assuming you have $C(0)$, the amount $K - \delta$ can be borrowed from a bank at annual rate r_b (n.a.c.a.) and the share bought at time $t = 0$. Writing $K - \delta = 0,5 S(0)[1 - f]$, the future value, in this case, of payments at 1 year is:

$$\begin{aligned} FV &= 0,5 S(0)[1 + f][1 + r_d] + 0,5 S(0)[1 - f][1 + r_b] \\ &= S(0) + 0,5 S(0)[r_d + r_b + (r_d - r_b)f] \end{aligned} \quad \dots (6)$$

The two transactions are equivalent in terms of equations (5) and (6) if and only if

$$f + r_d + fr_d = r_d + r_b + (r_d - r_b)f.$$

This means we should have $f = r_b / (1 + r_b)$. For the instalment option to be advantageous, we need:

$$f + r_d + fr_d < r_d + r_b + (r_d - r_b)f$$

i.e.

$$f < r_b / (1 + r_b) \text{ or } r_b > f / (1 - f). \quad \dots (7)$$

With typical $f = 10\%$, paying in instalments looks advantageous only if we exercise close to maturity and $r_b > 11,11\%$.

If however we exercise the option sooner, say at $t = 0,5$ and for $f = 10\%$, paying in instalments looks advantageous only if $r_b > f(2-f)/(1-f)^2$ i.e. $r_b > 23\%$!

3. BLACK-SCHOLES ANALYSIS

3.1 The price of the option and the greeks

Pricing formulae: From Black-Scholes (Hull, 2002) we have that the fair price (at $t < \tau$) of a vanilla (no barrier) T-maturity European call option on a non-dividend paying share, is:

$$C(t) = S(t)N(d_1) - Ke^{-r(T-t)}N(d_2) \quad \dots (8)$$

where

r is the discount rate for continuous compounding. The formulae for d_1 and d_2 can be found in (Hull, 2002).

In our case $N(d_1)$ and $N(d_2)$ are approximately 1 (d_1 and d_2 are larger than 3 for deep-in-the-money options), we can use the approximate pricing formula:

$$C(t) = S(t) - Ke^{-r(T-t)} \quad \dots (9)$$

For a deep-in-the-money option on a share paying dividends with present value D ,

$$C(t) = [S(t) - D] - Ke^{-r(T-t)} \quad \dots (10)$$

This follows from (9). (See also Chriss, 1997).

Since with an EDS we actually receive the dividend, we add D back again and regain the approximate Black-Scholes pricing formula (9).

An EDS is usually American, but since it is never optimal to exercise an American call option (no-dividend) early, the pricing formula and analysis of the EDS is approximately that of the European call.

From (9) the initial theoretical price of the EDS without barrier according to Black-Scholes pricing should therefore be

$$C(0) = S(0) - Ke^{-r} \quad (T = 1 \text{ and } t = 0). \quad \dots (11)$$

Comparing with $C(0) = 0,5 S(0) + \delta$

this means δ should be approximately

$$\delta = [0,5 S(0) - Ke^{-r}] = 0,5 S(0)[1 - e^{-r}]. \quad \dots (12)$$

Formula (12) could be used to compare the interest δ demanded by the writer, to that predicted by the Black-Scholes price for given rate r .

For example, if the holder paid $\delta = 0,05 S(0)$, this implies a discount rate of $r = 0,1054$.

If the option has a barrier L , the holder should pay less than the price given by equation (9), but for an EDS there is, at knockout, a rebate equal to the intrinsic value of the option. Since the time value is relatively small we argue that the fair price of this option should then be close to that given in (9) again.

We also have (Chriss, 1997, equation (4.5.1)) the following useful approximate relation for deep-in-the-money-options:

$$C(t) = S(t) - e^{rt} [S(0) - C(0)]. \quad \dots (13)$$

$$= S(t) - e^{rt} K + e^{rt} \delta$$

$$= S(t) - 0,9e^{rt} K \quad \text{for } \delta = 0,10K.$$

Exact pricing formulae for barrier options are quite complicated (Björk, 2004) and we will not go into further details. However, Table 2 compares actual option prices to those calculated by the approximate formula (9) and shows that the approximations are quite adequate for useful analysis.

Delta, vega and time value:

From (9) it is clear that the delta ($\Delta = \partial C / \partial S$) is 1. (At barrier L we can get $\Delta > 1$ for a short period of time.)

This is a consequence of the option always being deep-in-the-money. The option directly tracks the performance of the share – we have conservative gearing to share price movement.

$$\text{For } \Delta = 1, C(0) - e^{-rt} C(t) = S(0) - e^{-rt} S(t).$$

This is approximate. See (Chriss, 1997) equation (4.5.1). We can write this as

$$C(t) = S(t) - e^{rt} [S(0) - C(0)]. \quad \dots (14)$$

The vega of the option is $v = \partial C / \partial \sigma$ where σ is the volatility of the underlying share.

This is close to zero:

$$v = N'(d_1) = \left(1 / \sqrt{2\pi}\right) \exp(-d_1^2) \approx 0, \text{ because } d_1 \text{ is large.}$$

The option is therefore vol-insensitive: changes in the value of σ do not really affect the value of the option.

3.2 Selling the option instead of exercising it

In this section we compare the results when the option is sold before the expiry date, with the results of selling the underlying share.

In Table 3 we summarise the actual data (obtain from Sharenet) of a barrier EDS (a European call with initial underlying share price 1350 and initial option price 743) in May 2005. The market was bullish and either

selling the option or selling the share before the exercise date was profitable, with the option in the advanced position.

Table 4 shows the data in June 2007 of the barrier EDS with the same underlying share. The initial option price was 1874. In this case the market was decreasing and both the option and the share lost money, with the share in the better position.

Table 2: Percentage error in option pricing using approximation (9) with $r = 0,0915$

Share: $S(t)$	EDS option price	Black Scholes approximation	% Error
3050	1549	1505	2,8%
3128	1617	1584	2,0%
3130	1630	1587	2,6%
3130	1649	1587	3,7%
3185	1702	1642	3,5%
3212	1778	1670	6,0%
3280	1791	1738	2,9%
3260	1695	1719	-1,4%
3235	1717	1694	1,3%
3060	1563	1519	2,8%

Table 3: Profit: Selling option versus share (2005)

Share: $S(t)$	EDS option: $C(t)$	Selling option % Profit $(C(t) - C(0)) / C(0) \times 100$	Selling share % Profit $(S(t) - S(0)) / S(0) \times 100$
1720	1083	46%	27%
1670	1048	41%	24%
1655	1018	37%	23%
1625	1021	37%	20%
1650	1021	37%	22%
1620	977	31%	20%
1590	987	33%	18%
1630	993	34%	21%

Table 4: Profit: Selling option versus share (2007)

Share: $S(t)$	EDS option: $C(t)$	Selling option % Profit $(C(t) - C(0)) / C(0) \times 100$	Selling Share % Profit $(S(t) - S(0)) / S(0) \times 100$
3050	1549	-17%	-9%
3128	1617	-14%	-7%
3130	1630	-13%	-7%
3130	1649	-12%	-7%
3185	1702	-9%	-5%
3212	1778	-5%	-4%
3280	1791	-4%	-2%
3260	1695	-9%	-2%
3235	1717	-8%	-3%

4. SUMMARY

Exotic options make the pool of available financial instruments bigger and may have many attractive features. The aim of this paper has been to give some ideas on the basic analysis that can be done to provide insight into the value of EDS or instalment options.

Even a simple analysis shows that there are many factors to consider when buying such an option. Is the feature of limiting loss with a barrier attractive? What does the interest paid for the instalment feature amount to and how does it relate to other interest rates? Does the investor aim to eventually own the share, or take a view on a rising share price? Should the option be exercised early or should it be sold?

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