E Valuing equity-based payments

Executive remuneration packages generally comprise many components. While it is relatively easy to identify how much will be paid in a base salary — a fixed dollar amount — it can be far harder to determine the value of equity remuneration. Reporting requirements oblige companies to estimate the costs they *expect* to face from ‘at risk’ remuneration. Hence, there is often a difference between the *estimated* value of remuneration — that is, what a company expects to pay an executive in the relevant period ahead — and the *actual* amount that an executive ultimately receives. This is particularly true of options.

For the purposes of remuneration, ‘call’ options provide the recipient with the right, but not the obligation, to buy shares at a predetermined price (the exercise or ‘strike’ price) within a defined period of time (that is, on or before the maturity date, when the option expires). (This is differentiated from ‘put’ options, which grant the recipient the right to *sell* shares at the predetermined price.) In their standard form, executive share options are commonly set with the exercise price equal to the share price at grant date. However, specific types of options — such as performance rights — are set with a nil exercise price (as such, these are also referred to as ‘zero exercise price options’).

This appendix details the challenges of valuing options, including performance rights and other comparable equity-based payments. It discusses disclosure requirements for valuing options under accounting standards, and considers some of the mechanics of executive share options and how these might be handled by common option valuation techniques.

E.1 Disclosure requirements and fair value

Companies are required by the *Corporations Act 2001* (Cwlth) to disclose in their annual remuneration reports details of equity-based payments made to key management personnel and the five highest paid company and group executives. The Corporations Regulations 2001 further require that these payments are valued in accordance with accounting standards (chapter 5).

‘Fair value’ accounting standards for options, which attempt to reflect the expected future costs to a company from granting equity instruments to executives in the absence of a clear market price, are governed by the Australian Accounting Standards Board (AASB). The relevant standard on share-based payments — AASB 2 — specifies that this anticipated cost (an accounting value) must be calculated at the grant date, subject to an estimate of when the option or right will be exercised, and then amortised over the expected life of the instrument. This approach is consistent with international accounting standards.

According to AASB 2, the fair value of an option (and, by extension, its disclosed accounting value — see chapter 8) must be calculated with reference to six factors:

- its exercise price
- its expected life (how long before it expires or is exercised)
- the price (at grant date) of the share which the option gives a right to
- the expected volatility of that share price
- expected dividends on the share
- the risk-free interest rate.

Other factors should also be accounted for in the fair value calculation where these would be considered relevant to the option price by ‘knowledgeable, willing market participants’ (AASB 2, p. 31).

AASB 2 stipulates that the estimated fair value of an option cannot generally be revised after grant date (the main exception is if the equity grant is itself modified). This can often result in a divergence between reported and realised values. For example, the share price might increase strongly, providing a windfall gain to option holders, or it might fall sharply, resulting in an option becoming worthless (if the share price falls below the exercise price). The probability of these kinds of outcomes materialising is factored into the initial fair value.

Equity-based payments are commonly subject to performance hurdles. Often these are market-based (for example, total shareholder return (TSR)), and for this reason are relatively simple to include in valuing the option, depending on the technique chosen (section E.3). However, performance might also be measured against internal indicators or be based on achievement of specific milestones. Additionally, some equity-based payments might vest after an executive has remained employed by the company for a period of time (a service condition not linked to any performance requirements).

AASB 2 treats market-based performance conditions differently from non-market based and service conditions. Although market-based hurdles can be 'priced in' to the fair value, other vesting conditions must be accounted for separately. AASB 2 advises that companies should not adjust the fair value (per unit) for non-market based and service conditions, but should instead change the total number of equity instruments that are expected to vest (table E.1).

Where the probability of a market-based hurdle being met changes, this does not result in any amendment to the cost recorded by the company — the expense is still incurred even if the performance hurdle is never met. By contrast, where the probability of a non-market based hurdle or service condition being met changes, the company is required to adjust the number of equity instruments expected to vest, which in turn will modify the total recorded expense — the adjusted number of units multiplied by the (unchanged) per unit fair value. As such, if, for example, an executive fails to meet a service condition because of early departure from the company, then the number of instruments expected to vest would be revised down to zero, and the total expense would fall to nil (despite the per unit fair value remaining unchanged).

The inability to adjust the fair value applies to share-based payments that are settled in equity (for example, exercising an option or meeting the conditions of a performance right result in the provision of shares). However, it does not extend to cash-settled equivalents (for example, 'share appreciation rights' that mimic

Table E.1 **Summary of vesting and non-vesting conditions and their impact on valuation and accounting treatments**

		Performance conditions	
	Service conditions	*Market based*	*Non-market based*
Example conditions	Executive must remain with the company for 3 years	Target based on share price	Target based on successful initial public offering, with a specified service requirement
Include in fair value calculation?	✗	✓	✗
Accounting treatment if the condition is not met (after the grant date and during the vesting period)	**Forfeiture** Number of equity instruments expected to vest should be revised accordingly (in turn affecting the expense).	**No change** Company continues to recognise the expense over the remainder of the vesting period.	**Forfeiture** Number of equity instruments expected to vest should be revised accordingly (in turn affecting the expense).

Source: AASB 2008-1, p. 10.

options, except that the difference between the share price and the exercise price is paid out in cash). In accounting terms, cash-settled share-based payments represent a ‘liability’ rather than ‘equity’. For these cash-settled instruments, AASB 2 stipulates that the fair value must be updated at each reporting date and at the point of exercise (or, in the case of a cash-based performance right equivalent, upon vesting).

E.2 Time and value

Options granted today might not be exercised for several months or years (if at all). The cost to the company (and a financial benefit to the executive) will only be realised if and when the option is exercised. A call option will (likely) be exercised only when the share price exceeds the strike price — were this not the case, the holder could buy the shares on the market at the lower price. It is this difference between the strike price and the market-traded price — the ‘intrinsic value’ — that gives rise to a cost that must be borne by the company, and to a benefit that accrues to the executive.

However, the intrinsic value does not account for the entirety of an option’s value. An option’s ‘time value’ — which captures the possibility that at any point before expiry, the option might yet increase in value — decreases as maturity draws closer (Neal 2008). Put another way, the further away an option is from its expiry date, the greater the uncertainty as to its outcome at maturity. Where the outcome is certain — at expiration — the option value is entirely its intrinsic value.

Timing also matters for exercising options. ‘American’ options can be exercised at any time up until expiration. ‘European’ options can only be exercised on the specified maturity date. Most executive share options would be broadly classed as ‘American’, although vesting conditions may prevent executives exercising their granted option rights until specified hurdles have been met (section E.1). In this sense, executive share options are unlikely to be purely ‘American’ in style. This is not the only unique characteristic of executive share options (box E.1).

In the case of European options, the time until an option will be exercised (or not) is known — it is always the difference between the current time and its maturity date. However, for American options this time factor is unknown in advance, since there is a wider window in which the option can be exercised (any time up to and including maturity). In order to value an American option, the probability of early exercise must be considered (Barone-Adesi and Whaley 1987).

Box E.1 **Not for sale: executive share options**

Employee share options are different from the traded options available in securities markets. While options are ordinarily used by investors as a ‘hedging’ tool (that is, to mitigate financial risk), the intent of executive share options is to directly expose executives to firm-specific risk. Specifically, options granted as part of remuneration packages are non-transferable. Recipients cannot sell their options to third parties — they only have a choice as to whether they exercise the options or not.

Since executives cannot trade their options, the key way for them to reduce risk is to exercise their options and then sell the acquired shares (although vesting conditions and insider trading restrictions will limit how and when this can be done). This increases the likelihood of an option being exercised early, which in turn must be considered when estimating the instrument’s fair value.

Source: Boyd, Brown and Szimayer (2007).

For a standard, market-traded call option, this is not a significant problem. From an investor’s perspective, the worst possible outcome from a call option is a zero return — that is because if the strike price exceeds the market price, the option will (likely) not be exercised. By contrast, if an investor exercises an option early, the share price may later fall below the strike price — thus resulting in a loss if the acquired share is retained. (And given the time value, if the investor’s intent were simply to capitalise on the margin between the strike price and share price prior to the expiration date, then they would be better off choosing to sell the option rather than exercise it and sell the share.) For this reason, investors generally have an incentive to delay exercising an American option until its expiration (although this can be distorted by the payment of dividends from the underlying share). As such, the value of an American call option is, in theory, the same as an equivalent European call option that would expire on the same date (Merton 1973).

However, executives who receive equity are not typical investors (chapter 7). Executives are not permitted to sell their options, limiting their potential to diversify their investments. Given this non-transferability (and the higher portfolio risk it implies), executives might exercise options early to capitalise on the difference between share and strike prices. Klein and Maug (2009) found that behavioural factors (reactions to short-term trends in share prices) and institutional factors (for instance, vesting periods or the impact from mandatory trading ‘blackouts’ to prevent insider trading) were strongly correlated with US executives exercising their option rights prior to expiration.

The likelihood of early exercise has implications for both the cost to companies from granting options, as well as to the value placed on them by executives. Hall and Murphy (2002) suggest that executives place a higher value on American rather than European options, because early exercise provides executives with a way to diversify their portfolios (that is, exercise the options and sell the underlying shares), given that they cannot simply sell the options. However, early exercise by executives also leads to lower costs for companies, since early-exercising executives are forgoing the possibility of exercising when the share price is higher (that is, executives might exercise prematurely to ‘lock in’ gains, but miss out on the peak in share prices).

E.3 Valuation techniques

While AASB 2 provides a framework in which fair values must be calculated, no specific process for valuation is advocated. There are several alternative methods adopted for option valuation, each with their own advantages and disadvantages. Of these, the most common techniques are:

- the Black-Scholes model
- the binomial option pricing model
- Monte Carlo simulations.

Table E.2 provides a broad overview of the suitability of these pricing models in different circumstances. Each is explored in more detail in the subsequent sections.

Table E.2 **Suitability of valuation techniques**
What can they measure?

	Black-Scholes	*Binomial*	*Monte Carlo*
European options[a]	✓	✓	✓
American options[b]	✗	✓	✓
Absolute TSR hurdle	✗	✓	✓
Relative TSR hurdle	✗	✗	✓
Testing on average share price[c]	✗	✗	✓
Retesting of performance hurdle	✗	✓	✓
Share price target	✗	✓	✓

[a] An option that can only be exercised at maturity. [b] An option that can be exercised at any point up to maturity. [c] Where the performance hurdle (either absolute or relative) is based on an average share price over a period of time, rather than a single price at a specific point in time.

Source: Gibson and Hogan (2006, p. 50).

Black-Scholes

Published in 1973, the Black-Scholes model is taken to be the foundation of option pricing. Consequently, it has been commonly applied by companies valuing remuneration packages.

In the context of valuing call options, Black-Scholes recognises that the higher the price of a given share, the more valuable an option to buy that share becomes (where the share price exceeds the strike price). Black-Scholes estimates the expected share price at an option's expiration date, using this to derive the value of the option itself.

The Black-Scholes valuation formula (box E.2) is subject to several 'ideal conditions', namely that:

- the short-term, risk-free interest rate is known and constant over time
- the share price follows a 'geometric Brownian motion' — a continuous time stochastic process which roughly approximates observed behaviour in financial markets (excluding extreme events)
- the share does not pay dividends
- the option is a European option
- there are no transaction costs
- shares are perfectly divisible, hence one can buy any fraction of a share (and borrow the money to do so at the short-term, risk-free interest rate)
- there are no 'short selling' restrictions, such that a person can sell a security they do not actually own at the time of the sale (but will at some future point in time have ownership of, in order to complete the trade) (Black and Scholes 1973).

The strongest advantage of Black-Scholes is its relative simplicity compared with other pricing techniques. But simplicity can be a problem when dealing with complex derivative structures. In particular, as application guidance for AASB 2 notes, Black-Scholes might not always be consistent with accounting standards (AASB 2, p. 31).

The strict assumptions of Black-Scholes mean that deviation from these conditions will cause inaccuracies in the model's valuations. While there are some measures that can account for certain differences (for instance, Black-Scholes can be adjusted to allow for dividends to be paid, as in Merton (1973)), this is not the case for all the assumptions.

Box E.2 **Black-Scholes formula**

The Black-Scholes model assumes the following form to estimate the value of a call option:

$$C_{S,t} = S_t N(d_1) - Ke^{-(T-t)r} N(d_2)$$

Where:

- $N(d)$ represents the normal cumulative distribution function of d, and:

$$d_1 = \frac{\ln(\frac{S_t}{K}) + (r + \frac{\sigma^2}{2})(T-t)}{\sigma\sqrt{(T-t)}}$$

$$d_2 = d_1 - \sigma\sqrt{(T-t)}$$

- e is the exponential function.

Hence, $C_{S,t}$ (the price of a call option at time t given the share price) is a function of:

- S_t, the price of the share at the current time
- K, the exercise price
- r, the short-term, risk-free interest rate
- $T - t$, the difference between (respectively) the option's maturity date and the current time
- σ, the volatility of the share price (specifically, its annual standard deviation).

Source: Black and Scholes (1973).

One of the biggest limitations of Black-Scholes as a tool for quantifying the value of options in remuneration packages is the assumption of European options, when most options offered to executives are broadly American-style. Depending on the circumstances, this can mean that Black-Scholes might not be particularly effective at estimating either the cost to the company (which could be overstated) or the value to the executive (which could be understated).

Binomial option pricing

Binomial option pricing (also known as binomial lattice modelling) was proposed by Cox, Ross and Rubinstein (1979) (box E.3), and is a more complicated process than Black-Scholes. It has the advantage of being able to cater to a wider variety of conditions, including American (rather than just European) options.

Box E.3 **Binomial option pricing model**

Calculating the share price

The probability of an increase in the share price (p) is given by:

$$p = \frac{a - d}{u - d}$$

Where:

- a is the 'growth rate', given by: $a = e^{r\Delta t}$
- u is the effect on the share price from an upwards movement, such that $u = e^{\sigma\sqrt{\Delta t}}$
- d is the effect on the share price from a downwards movement, such that $d = e^{-\sigma\sqrt{\Delta t}}$
- Δ reflects a unit change (for example, Δt is the change in time period)
- and all other notation is consistent with box E.2.

(The probability of a decrease in the share price is $1 - p$.)

Starting from an initial share price, $S_{t=0}$, each upward movement in price in subsequent periods can be calculated by $S_{t+\Delta t} = S_t u$, and similarly any downward moves by $S_{t+\Delta t} = S_t d$.

Calculating the option value

The option values for all share price outcomes at expiry are easily calculated — the option price is equal to the intrinsic value of the share:

$$C_{S,t} = \max(S_t - K, 0)$$

The option values in earlier time periods are expected values based on the probabilities of the share price increasing and decreasing:

$$C_{S,t} = (pS_{u,t+\Delta t} + (1 - p)S_{d,t+\Delta t})e^{-r\Delta t}$$

Where subscripts u and d relate to the corresponding upward and downward movements originating from S_t into the next time period.

Where early exercise is possible (for instance, American options) this becomes:

$$C_{S,t} = \max((pS_{u,t+\Delta t} + (1 - p)S_{d,t+\Delta t})e^{-r\Delta t}, S_t - K)$$

Sources: Cox, Ross and Rubinstein (1979); Tupala (2006).

The binomial pricing model estimates the fair value of an option held today by projecting how the share price will vary over time. The model assumes that at any point in time, the share price can increase or decrease. (A variant of this, trinomial pricing, allows for a third alternative: an unchanged share price.) The price trees generated in the Cox, Ross and Rubinstein (1979) version of the model are recombining, such that a price movement 'up' in one time period followed by a 'down' in the next period will always return the share price to where it was before.

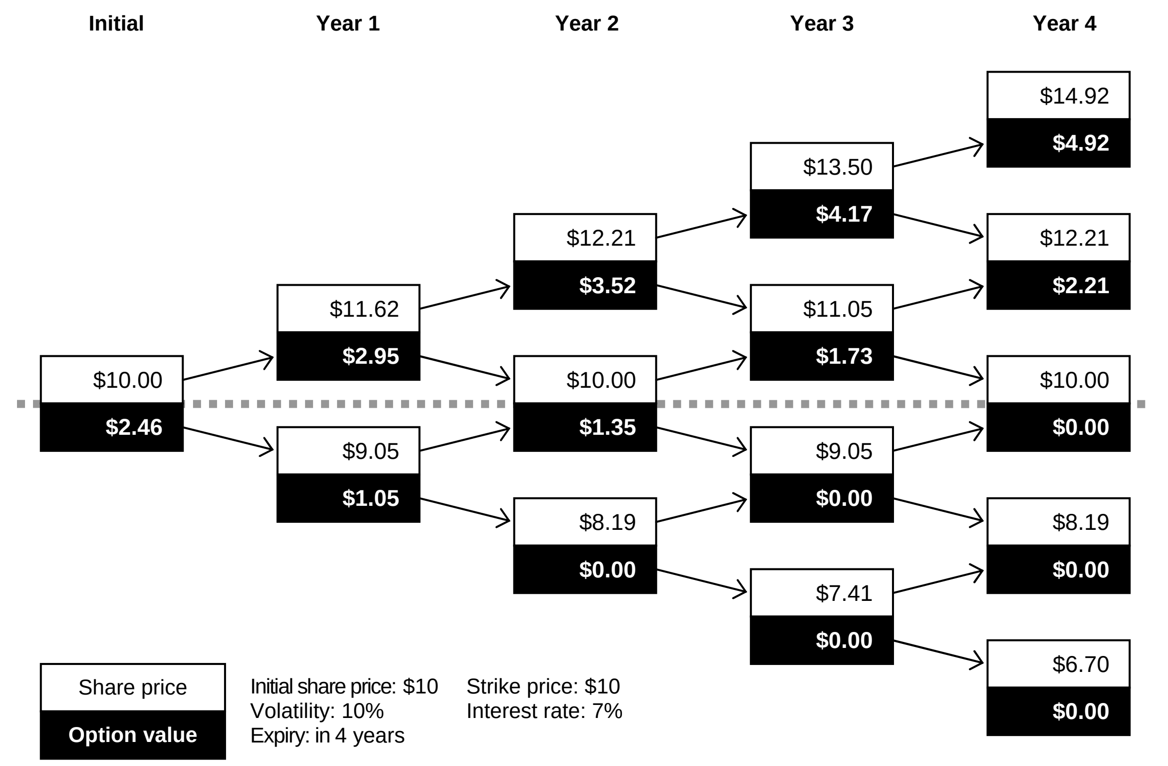
Once the future share prices are projected, then the option value can be traced backwards — the option price for each projected outcome at the expiry simply being the intrinsic value, while those in previous periods are expected values based on the probabilities of the share price increasing and decreasing.

An illustration of how the binomial model works is presented in figure E.1. The example assumes:

- an initial share price (S_t) of $10
- a strike price (K) for a call option of $10
- expiry ($T - t$) in 4 years
- share price volatility (σ) of 10 per cent
- a risk-free interest rate (r) of 7 per cent.

Figure E.1 **A binomial price tree for an American option**[a]

Work forwards for share price, work backwards for option value



a In this particular example, the model's results would be the same for an equivalent European option (see section E.2).

In this simple case, there is no dividend payable, nor are any vesting periods applied. With only four steps (of one year each) considered, the model estimates a current option value of $2.46.

While this is a simple example, it is important to note that additional complexity can be built into the model relatively easily. For instance, an annual dividend yield can be accounted for in the model. Vesting periods — where an executive holds a share, but cannot exercise any rights — can also be incorporated. Early time periods can be treated as European options (that is, early exercise is not permitted) while later periods (when the options have vested, and can be exercised) are treated as American options (Liu 2003). It is also fairly straightforward to account for situations where vesting is contingent on meeting market-based performance hurdles, since the valuation process already projects the potential outcomes in the share price.

A potential weakness of the binomial option pricing model is that it is a discrete time function, whereas Black-Scholes is continuous in nature. The price tree depicted in figure E.1 implies that only five possible share prices are possible after four years. Even if the assumed volatility limited the share price to between the highest and lowest prices, the share price in reality could end up at any price point within that range. The simplification brought about by the binomial model will tend to result in reduced accuracy in the pricing of options. However, this can be mitigated merely by increasing the number of time steps. For example, instead of four discrete jumps (each representing one year), one could model steps for each trading day over the four year period (approximately 1000). This would improve accuracy, but would also require more time to calculate.

A more considerable limitation relates to the benchmarking of corporate performance. While binomial option pricing can allow for performance hurdles related to changes in the underlying share price (for example, vesting conditions that require achievement of an absolute TSR target), there is no natural capacity to account for share price performance relative to peers or to the broader index (Gibson and Hogan 2006). Hence, where companies use relative TSR or a similar market-based hurdle which is compared against a peer group's performance, binomial option pricing might not (on its own) provide the most accurate valuation.

Monte Carlo simulations

Monte Carlo simulations have broad applicability, with uses extending far beyond the field of finance. Boyle (1977) identified the technique's relevance to derivatives valuation.

Addressing uncertainty, Monte Carlo simulations rely on random numbers to generate a range of different outcomes, which can be averaged to an expected value. It is not itself a valuation technique — rather, it provides a framework for simulating the outcomes defined by a valuation model. The approach offers perhaps the greatest flexibility of the techniques considered, able to handle far more exotic types of derivatives than those commonly used for executive remuneration packages.

Box E.4 provides a simple example to illustrate how Monte Carlo techniques can be used to simulate Black-Scholes. Importantly, while the example replicates Black-Scholes, Monte Carlo simulations can be specified in any way. (Black-Scholes is chosen here purely for consistency with the preceding sections.) Many companies report using Monte Carlo techniques in combination with binomial option pricing (for example, Woolworths, sub. 91). The strength of the Monte Carlo method is its ability to accommodate complex models that can address different conditions. Specifying the correct model is thus paramount to ensuring that executive share options are accurately valued.

Gibson and Hogan (2006) note that Monte Carlo techniques are more likely to be used where a number of different share prices must be considered. This is true of relative TSR hurdles, where not only the company's own share price must be modelled, but also that of peers against which performance is benchmarked. Monte Carlo simulations are also capable of pricing options where performance hurdles or payoffs are set according to an average share price over a period of time rather than a single share price at a specific point in time.

If a solvable equation can be specified that can accurately account for the various conditions of the option — for instance, Black-Scholes and non-dividend paying European options — then there is little advantage to using Monte Carlo simulations. As box E.4 shows, tens of thousands of simulations must be run to reach a figure that closely approximates the 'true' result. In this regard, parallels can be drawn with binomial option pricing: just as accuracy with the binomial option pricing model is improved by increasing the number of steps (that is, reducing the duration of the individual time periods considered), Monte Carlo modelling becomes more precise the greater the number of iterations that are run.

Box E.4 Simulating Black-Scholes using Monte Carlo techniques

The source of share price uncertainty is captured in Black-Scholes by the condition of geometric Brownian motion. This is commonly reflected as:

$$\Delta S_t = \mu S_t \Delta t + \sigma S_t \Delta W_t$$

Where:

- μ is what Merton (1973) describes as the 'instantaneous expected return on the common stock' (p. 162), also known as 'drift'
  - under the condition of risk neutrality, $\mu = r$
- W_t is the Brownian motion, also known as a Wiener process
- and all other notation is consistent with boxes E.2 and E.3.

This solves for the share price at maturity (S_T):

$$S_T = S_t e^{(r - \frac{\sigma^2}{2})(T-t) + \sigma(W_T - W_t)}$$

Here, $(W_T - W_t)$ is a variable which is log-normally distributed with a mean of zero and a variance of $(T - t)^{½}$. Hence it can be produced by, for instance, generating a random number between 0 and 1 and multiplying the results by $(T - t)^{½}$. It can then be entered into the formula to determine the share price at maturity. The Monte Carlo simulation entails drawing random numbers successive times, entering each of these into the formula and then averaging the results to determine the expected value of the share price at maturity (and, by extension, the current option value when discounted back).

Example

In the previous discussion of the binomial option pricing model, a call option for a share with no dividend payable was considered. For consistency, assume the same conditions (although here a European option is considered): that the initial price for the underlying share is $10 with volatility of 10 per cent, and that the option has a strike price of $10, with expiry in 4 years time. The risk-free interest rate is 7 per cent.

The Black-Scholes model, which is a relevant valuation method for this case, gives a fair value for the option of $2.51. Monte Carlo simulations provided the following results:

Results

Random numbers generated	*10*	*100*	*1 000*	*10 000*	*100 000*
Estimated option value	$1.74	$2.41	$2.56	$2.50	$2.51

As the results above indicate, the more iterations that are run, the greater the accuracy of the Monte Carlo approach in calculating the option value.

Sources: Merton (1973); Chance (2008); Léger (2006).