THE MINIMUM ASSUMED INCENTIVE EFFECT
OF EXECUTIVE SHARE OPTIONS

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ABSTRACT

In granting executive share options (ESOs), companies hand over financial assets to the executive at an opportunity cost that generally outweighs the value placed on those assets by the executive on the receiving end. This outcome can be explained by risk aversion on the part of the executives. For such transactions to make commercial sense, the difference in valuation must be at least made up by the impact of the incentive effects induced by compensating executives in this particular manner. This paper extends such a line of analysis to examine the executive's reward-risk trade-off, in addition to the certainty-equivalent pay-performance sensitivity, and uses a UK data set to provide some estimates of the size of these effects.

1.   Introduction

Some commentators have been puzzled as companies load up the remuneration packages of their executives with executive share options (ESOs) and other long-term company-specific equity instruments. From one perspective, such behaviour can be explained as a device for improving reported earnings, in the sense that in many accounting jurisdictions (the UK and the USA, for example) there has been no obligation on the company to expense such components of remuneration by recording them on the expenditure side of the income statement.

The behaviour appears odd, of course, because the executive on the receiving end of this form of remuneration generally values such equity-based components of pay at less than the opportunity cost to the company awarding them. This is due to risk aversion on the part of executives who, in addition to having specific human capital investments in a company, may already hold part of their wealth in the form of company-specific equity. In terms of straight remuneration, a Pareto improvement, therefore, appears to go begging, in the sense that the company could provide the executive with a cash payment that not only is preferred by the executive to the ESOs it replaces, but also costs the company less. The company appears to choose an expensive way of remunerating its senior executives.

A more robust explanation of the widespread use of ESOs and their apparent excess cost can be found in terms of managerial incentives. Consider a company that grants to an executive a package of ESOs that would otherwise (on the open market) be valued at £300,000. Suppose that this executive already has much of his or her human capital tied up in the firm and also has existing savings in the form of company shares or earlier tranches of ESOs. Any risk aversion on the part of the executive will, therefore, cause the executive to discount in valuation the most recent package of ESOs to an extent that it may have a certainty-equivalent (cash) value well below the £300,000 opportunity cost to the company.   However, the fact that remuneration is hereby delivered in a deferred mode that is contingent on company performance may well result in an improved

alignment in managerial incentives and, consequently, an increase in company performance. This increase in company performance may lead to an enhancement in company valuation that is assumed to be at least equal to any such excess cost of the ESO package to the shareholders, so making ESOs a technique of remunerating executives favoured by shareholders. We call this assumed increase in company valuation the minimum assumed incentive (MAI) effect.

This paper attempts to quantify the size of this MAI effect of executive share options (ESOs) by calculating how much the market value of the ESO component of pay exceeds the value of that component to the executive. In so doing, we draw on the Lambert, Larcker and Verrecchia (1991) and Hall and Murphy (2002) model of the valuation of ESO grants. We both illustrate some of their results (in, for example, Figure 1) and extend the model (in, for example, Figures 2 and 4) to compare executive attitudes to risk both with and without a share option component in the pay package. Thus, the paper addresses the question of incentives for executives more directly than an extensive literature (see Murphy, 1999) that considers their evaluation only in terms of the ex-post association between company share price performance and the cost of executive rewards to the firm. This conventional approach assumes that rewards are influenced by performance. However, this paper focuses on the incentive effects of executive rewards, where rewards are assumed to influence performance.

Besides inducing managers to supply shareholder-aligned effort, a deeper agency problem is how to provide incentives for managers to promote shareholder value under inefficient risk-sharing (Holmstrom, 1992). If the main purpose of a compensation system is to align managerial interests with shareholders' objectives, then this must also include aligning their risk preferences (Murphy, 1999), and substantial efforts are made to design complex executive contracts that address such issues (Kole, 1997). The analysis below extends the certainty-equivalence framework of Lambert et al. (1991) and Hall and Murphy (2002) in order to examine ESO grants as a tool to lessen the potential conflict of interest between owners of firms and their managers.

Risk-averse executives, rewarded mainly with fixed salaries and subject to the penalty of job loss for failure, have no obvious incentive to take risks that are expected to be profitable. While often associated with an alleged lack of downside risks for executives, owing to the common misperception that no obvious losses occur when market prices fall below exercise prices, ESOs have been seen to have a potential to induce risk taking by executives. They appear to have the potential to align more closely the utility functions of executives with risk-neutral shareholders, reducing managerial conservatism in risk-taking (Agrawal and Mandelker, 1987; De Fusco, Johnson and Zorn, 1990). On the other hand, however, it has now been recognised that in-the-money or at-the-money ESOs may lose their risk-inducing potential (Lambert et al., 1991; Carpenter, 2000). ESOs may actually increase downside risks, and empirical results have been produced to support the roles of ESOs in promoting both risk-taking and conservatism in risk-taking.

This paper addresses these differences and explains that important contingent valuations that confront the individual executive can reconcile these chameleon-like properties of the ESO. This paper contributes to the debate with a certainty-equivalence approach owing to Lambert et al. (1991) and Hall and Murphy (2002). From this perspective, mixed results can be reconciled, and new results are generated that identify the contingencies confronting individual executives in certain industries, where different outcomes may follow. The results suggest that the majority of modern ESO schemes in the UK fail to tackle behaviour by top managers considered by shareholders to be excessively cautious. This finding corresponds with the empirical finding of Wiseman, McNamara and Devers (2001) of a negative relationship between share option grants and firm risk

In Section 2 of the paper, the Lambert et al. (1991) and Hall and Murphy (2002) model is utilised and extended to investigate the impact of ESOs on executive utility. Section 3 deploys data on Chief Executive Officers (CEOs) from FTSE350 firms in 1997/98 to derive empirical estimates of these effects. The paper concludes in section 4 with a discussion of current government and institutional policy toward executive pay in general, and ESOs in particular.

2. Model

2 (i) Executives' Valuations of Option Grants.

Following Lambert et al. (1991) and Hall and Murphy (2002), we estimate the value of a non-tradable option to an undiversified risk-averse executive as the amount of riskless cash compensation that the executive would exchange for the option. Before such valuations, however, we first address the cost to the company of granting ESOs. Adopting the Hall and Murphy (2002) framework, we consider an executive with initial wealth $w = £2$ million, split between riskless cash and company shares. Assume the executive to receive share options with a Black-Scholes value[1] of £300,000 with $T = 10$ years to maturity, a volatility $\sigma = 0.3$ of the underlying share, and a risk-free market rate of $r = 0.055$ per annum[2]. The Black-Scholes formula[3] gives the *cost to the company* of the grant of options as:

$$BS(P_0, X) = P_0 \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{y_1(P_0,X)} e^{-\frac{t^2}{2}} dt - Xe^{-rT} \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{y_2(P_0,X)} e^{-\frac{t^2}{2}} dt \qquad (1)$$

where, P_0 is a share price at the moment of grant, X is an exercise price, and

$$y_1(P_0,X) = \frac{1}{\sigma\sqrt{T}}\left(\ln\left(\frac{P_0}{X}\right) + T\left(r + \frac{\sigma^2}{2}\right)\right), \quad y_2(P_0,X) = \frac{1}{\sigma\sqrt{T}}\left(\ln\left(\frac{P_0}{X}\right) + T\left(r - \frac{\sigma^2}{2}\right)\right) \quad (2)$$

The number of options granted, therefore, is given by $N(P_0,X) = \dfrac{300000}{BS(P_0,X)}$. However, the Black-Scholes formula assumes risk-neutrality of the agent and, consequently, while

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[1] For a given share price, volatility etc., the actual number of options granted increases with the exercise price.

[2] This was the prevailing yield on 10 year government gilts at the time.

[3] No dividends are considered, since, as in Hall and Murphy (2002), the incorporation of dividends does not change qualitative results. See Hull (1993) for formulae. Considerations of vesting restrictions, company take-over events, executive mobility, and lack of access to a secondary market mean that the Black-Scholes formula is only a crude approximation of the opportunity cost of ESOs to the company.

applicable for the calculation of company cost, this formula is not accurate in the assessment of *an executive's valuation* of the options. Due to risk aversion, one can hypothesise that undiversified executives would value options below their Black-Scholes value.

Following Hall and Murphy (2002), given an executive's initial (pre-option grant) wealth of *w,* the executive's wealth at time T can be modelled as:

$$W_T = W_T(P_0, P_T, k, X) = (1-k)w(1+r)^T + kw\frac{P_T}{P_0} + N(P_0, X)\max(0, P_T - X) \qquad (3)$$

where, P_T is the realised share price at time *T,* and *k* is the fraction of initial wealth tied up in company shares. (Three alternatives are considered[4] in the subsequent analysis, with k = 10%, k = 20% and k = 30%.)

The award of riskless bonds V instead of options would leave the executive with wealth:

$$W_T^V = W_T^V(P_0, P_T, k, V) = \left((1-k)w + V\right)(1+r)^T + kw\frac{P_T}{P_0} \qquad (4)$$

The 'certainty equivalence' approach defines an executive's valuation V = VS(P₀, k, X) of the option grant as the value of bonds that equates the executive's expected utility of wealth from the two sources $U(W_T^V)$ and $U(W_T)$ under the perceived distribution of future share prices, f(P_T):

$$\int U(W_T(P_0, P_T, k, X))f(P_T)dP_T = \int U(W_T^V(P_0, P_T, k, VS))f(P_T)dP_T \qquad (5)$$

Following Lambert et al. (1991), subsequent analysis assumes the utility function of the executive to be:

$$U(W) = \begin{cases} \dfrac{W^{1-\rho}}{1-\rho}, & \rho \neq 1 \\[2ex] \ln(W), & \rho = 1 \end{cases} \qquad (6)$$

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[4] Hall and Murphy (2002) utilise k = 33%, k = 50% and k = 67% but, while reasonable in the context of the USA, these values are too high to reflect the typical own-company equity exposure of British CEOs.

where, ρ is constant relative risk-aversion[5].

We use a lognormal distribution of share prices to solve (5) for VS. This assumption of a lognormal distribution of share prices is usual in theory and in practice, for instance the derivation of the Black-Scholes formula is implicitly based on this assumption. Hence, we model a distribution function $f(P_T) = f(P_T|P_0)$ of the share price P_T at time T, given share price P_0 at time zero as[6]:

$$f(P_T|P_0) = \frac{1}{\sigma\,P_T\,\sqrt{2\pi T}}\exp\left[-\frac{\left(\ln\frac{P_T}{P_0} - T\left((r+.035)-\frac{\sigma^2}{2}\right)\right)^2}{2\sigma^2 T}\right]$$ (7)

The numerical solution of equation (5) for VS gives the executive's certainty equivalent valuation of the option grant, which is typically lower than its Black-Scholes cost. It is worth noting that the executive's valuation may actually be higher than the Black-Scholes cost when the recipient is sufficiently well diversified. As Hall and Murphy (2002, p12) note, this may occur owing to the executive's valuation of the option grant reflecting the risk premium that is incorporated in the expected shareholder return to that particular share[7] (something that is diversified away in the Black-Scholes valuation). Of course, most executives are sufficiently exposed to risk through holding other equity instruments in the company that this marginal return is overwhelmed by the discounting effect of risk-aversion.

2(ii)   The Essential Properties of Option Grants.

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[5] Recipients with ρ =2 and w =£2 million are indifferent between a 50% chance of an extra £300,000 and a 50% chance of nothing, and a certain £139,535. For recipients with ρ =3, the certainty equivalent becomes £134,347, and for ρ =4 it becomes £129,220.

[6] Following the 2.55% to 4.32% estimated range in Fama and French (2001), we assume a risk premium of 3.5%.

[7] This return, using the Capital Asset Pricing Model, is $r = r_f + \beta(r_m\text{-}r_f)$, where r_f is the risk free rate, r_m is the market rate of return, and β is the CAPM beta. Here the risk premium, $(r_m\text{-}r_f)$ is assumed to be 3.5%.

Hall and Murphy (2002) argue that the derivative $\dfrac{\partial VS}{\partial P}$ represents the incentive to increase share price provided by the option grant, since it shows the change in the certainty-equivalent value of the grant following a small change in share price, i.e. the risk-adjusted pay-performance sensitivity of the grant. Implicit differentiation of equality (5) gives this pay-performance sensitivity of the option grant as:

$$\frac{\partial VS(P_0, k, X)}{\partial P} = \frac{\int\limits_0^\infty \Big(U(W_T(P_0, P_T, k, X)) - U(W_T^V(P_0, P_T, k, VS)) \Big) \dfrac{\partial f(P_T | P_0)}{\partial P} dP_T}{(1+r)^T \int\limits_0^\infty U'(W_T^V(P_0, P_T, k, VS)) f(P_T | P_0) dP_T} \tag{8}$$

where, $U'(W) = W^{-\rho}$ is the first derivative of $U(W)$ with respect to the value W of the total package. Figure 1 depicts the pay-performance sensitivity $\dfrac{\partial VS(P, k, X)}{\partial P}\Big|_{P=P_0}$ of the option grant with a Black-Scholes value of £300,000 granted to undiversified risk-averse executives with $\rho = 4$ and respectively $k = 10\%$, 20% and 30% of initial wealth in shares. A total initial wealth of £2million is assumed.

Figure 1
Change in the Executive's Valuation
of £300,000 of Options per £1 Change in Exercise Price

$\partial VS/\partial P$

K=10%
K=20%
K=30%

Exercise Price
(assuming current share price = £30)
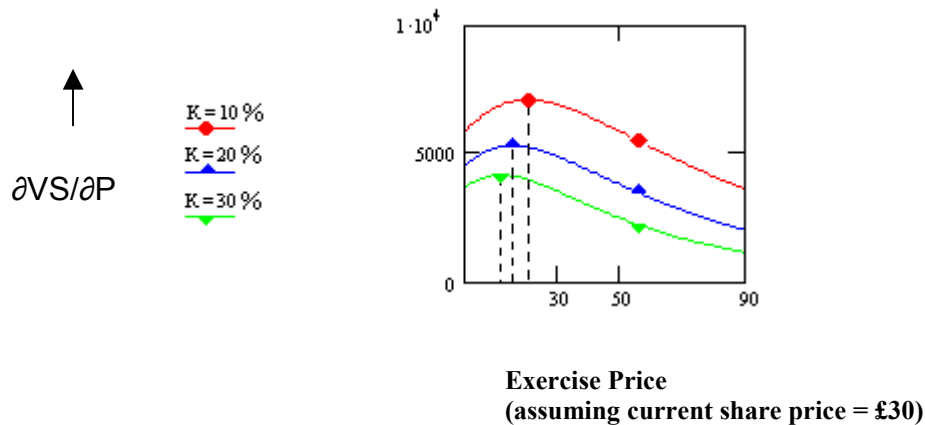
(**Note:** Exercise price at maximum pay-performance sensitivity is shown in Figure 1 for k=10% to be equal to: £20.50 (68% of share price); for k=20%, £15.40 (51% of share price); and for k=30%, £11.50 (38% of share price)).

As can be seen, the option grant provides a lower incentive to less diversified executives (higher k). The exercise price that maximises risk-adjusted pay-performance sensitivity (PPS) is also lower for less diversified recipients. However, incentives are relatively stable around the maximum, which gives the firm the 'freedom' to choose the exercise price within a certain range. With these holdings of options, when the share is 'at the money', a £1 change in share price brings to the executive a change in wealth of £6,850 (k=10%), of £4,850 (k=20%) or of £3,540 (k=30%). As the note to Figure 1 highlights, maximum sensitivity to performance always occurs when the options are in the money.

Apart from the share price, the certainty-equivalent value of the option grant $VS(P_0,k,X)$ also depends on the expected volatility, σ, of the underlying shares. So far, volatility has been held at 0.3 in the analysis. Assuming that executives understand how their actions affect share prices, we can also assume that they have beliefs about the simultaneous effects of their actions on share price volatility. An executive's propensity to take risks could be measured as the share price increase that keeps executive wealth indifferent to a

certain increase in share price volatility. The higher the minimum price increase that the executive would require for a certain increase in volatility, the more conservative the executive will be in strategic decisions. Agrawal and Mandelker (1987) find a positive relationship between executive option holdings and both increased return variance and increased company debt-equity ratio. These findings are echoed in DeFusco et al. (1990). On the other hand, both Lambert et al. (1991) and Carpenter (2000) argue that giving managers more share options can cause them to reduce volatility.

Implicit differentiation of (5) with respect to variance, σ^2, combined with (8) gives the risk premium which keeps the executive's option valuation (though not total wealth) indifferent to incremental changes in the share price volatility:

$$\frac{\partial P}{\partial \sigma^2}\left\{VS(P_0,k,X,\sigma) = const\right\} = -\frac{\dfrac{\partial VS}{\partial \sigma^2}}{\dfrac{\partial VS}{\partial P}} =$$

$$= -\frac{\displaystyle\int_0^\infty \left(U(W_T^V(P_0,P_T,VS,k)) - U(W_T(P_0,P_T,k,X))\right)\frac{\partial f(P_T \mid P_0)}{\partial \sigma^2}dP_T}{\displaystyle\int_0^\infty \left(U(W_T^V(P_0,P_T,VS,k)) - U(W_T(P_0,P_T,k,X))\right)\frac{\partial f(P_T \mid P_0)}{\partial P_0}dP_T} \qquad (9)$$

Figure 2 plots the reward-risk trade-off imposed by the option granted to executives with $\rho = 4$ and 10%, 20% and 30% of initial wealth in shares. The vertical axis in Figure 2 indicates, for various exercise prices, the increase in share price necessary to keep an executive's valuation of a tranche of options constant, given a prevailing share price of £30, when variance[8] increases by 0.01.

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[8] For a 0.01 increase in variance, σ^2, when initial assumed volatility σ is 0.3, this implies that volatility rises approximately to 0.316, which gives and increase of 0.016, or 5.4%, in volatility.

Figure 2
The Reward-risk Trade-off resulting from a £300,000 Option Grant
(i.e., the increase in share price that keeps the executive's value of the grant constant
under 0.01 increase in variance) (£)

$\partial P/\partial(\sigma^2)$

K = 10 %

K = 20 %

K = 30 %

Exercise price
(assuming current share price = £30)
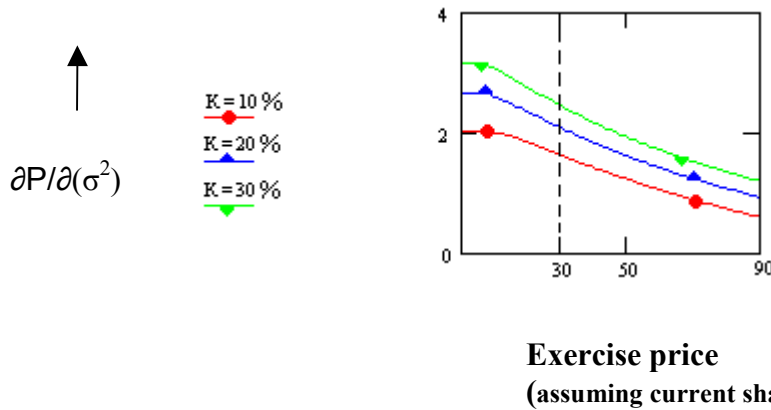
(In each case these profiles have a maximum at the intercept with the vertical axis, i.e., restricted shares. In terms of 'at-the-money' options (exercise price =£30) the reward-risk trade-off when k=10% is £1.63; when k=20%, £2.10; and when k=30%, £2.47).

Unsurprisingly, the reward for risk taking demanded by executives (in the form of share price appreciation) is higher for less diversified executives. It is also not surprising that out-of-the-money options impose less conservative attitudes towards risk. It can be noted that the reward for risk demanded by executives, being a relatively stable function for deep in-the-money options, can fall quite significantly if exercise price is set above share price, and this general finding does not depend on the diversification level of recipients.

The analysis that has been undertaken to this point provides some useful qualitative properties of the executive's valuation of option grants. However, it is difficult to assess the comparative advantages and disadvantages of option grants as part of the pay package solely on the basis of these free-standing figures that relate solely changes in option package valuations. Incentives created by option grants should be examined in the context of the properties of the total pay package. To tackle this question, we analyse the incentive aspects of executive pay packages with and without options (strictly, just before and immediately after the option grant).

2(iii)   The Impact of Option Grant on the Properties of the Total Pay Package.

In this section, the same certainty–equivalence framework is applied to the total pay package before and after options are granted. Hence, this section presents the impact of option grants on the executive's motivations. The impact is more intuitively satisfying than the earlier option-package-only figures since it shows the relative efficiency of option grants as a tool deployed to mediate agency problems. The changes to the model are minimal. We consider the same hypothetical risk-averse executive with initial wealth $w = $ £2million, split between riskless cash and company shares. Before the options are granted, all pay-performance sensitivity and conservatism in decision-making comes from the presence of company shares in the executive package. After option grant, as far as pay-performance is concerned, options just add their rewards for price appreciation to those of shares. However, the mixture of reward-risk trade-offs imposed by shares and by options is not so straightforward. Options not only introduce a new trade-off, but also impact on the existing share-derived trade-off.

In order to calculate the risk-adjusted pay-performance-sensitivity (PPS) of the entire package, we have to amend equation (8) slightly. We are still within the same model, but now we consider the properties of the package as a whole. Following the idea of 'certainty equivalence' and equation (5), we define executives' valuations of their total wealth V_{tot} as the value of riskless bonds that would have equivalent utility to the expected utility of their total wealth. Equation (5) can, therefore, be rewritten as,

$$\int U(W_T(P_0, P_T, k, X)) f(P_T) dP_T = \int U((1+r)^T V_{tot}) f(P_T) dP_T \qquad (10)$$

Bonds V_{tot} are granted at time 0 and do not depend on the share price P_T. As a result, the equation is simplified to

$$\int U(W_T(P_0, P_T, k, X)) f(P_T) dP_T = U((1+r)^T V_{tot}) \qquad (11)$$

The PPS of the package is the first derivative of an executive's valuation of the wealth V_{tot} with respect to share price and is equivalent to equation (8),

$$\frac{\partial V_{tot}(P_0, k, X)}{\partial P} = \frac{\int_0^\infty U(W_T(P_0, P_T, k, X)) \frac{\partial f(P_T | P_0)}{\partial P} dP_T}{(1+r)^T U'((1+r)^T V_{tot})} \tag{12}$$

We define *executive conservatism in risk-taking* as the price increase that keeps the executive's valuation of the total pay package unchanged after a certain increase in share volatility. In economic terms it is the rate of substitution of two factors and is represented by the implicit derivative RR,

$$\text{RR} = \frac{\partial P}{\partial \sigma^2} \{ V_{tot}(P_0, k, X, \sigma) = const \} = -\frac{\frac{\partial V_{tot}}{\partial \sigma^2}}{\frac{\partial V_{tot}}{\partial P}} =$$

$$= -\frac{\int_0^\infty U(W_T(P_0, P_T, k, X)) \frac{\partial f(P_T, P_0)}{\partial \sigma^2} dP_T}{\int_0^\infty U(W_T(P_0, P_T, k, X)) \frac{\partial f(P_T, P_0)}{\partial P} dP_T} \tag{13}$$

The derivation of equation (13) is similar to that of equation (9).

Using equation (12), Figure 3 depicts a percentage increase in the PPS of the total package after the option grant with a Black-Scholes value of £300,000. Because of the simple additive nature of pay-performance sensitivity, Figure 3 closely resembles Figure 1. Figure 3 emphasises, however, that the increase in the executive's incentive to create shareholder value in relative terms depends heavily on the overall structure of the executive package prior to the grant, particularly on the proportion of executive wealth tied up in company shares. Thus, other things equal, less diversified executives would be less motivated by an option grant of a fixed Black-Scholes value both because this grant is relatively less significant to them and because of the implied discount of its value due

to the greater risk exposure.

Figure 3
Increase in Total PPS of the Pay Package as a Result of the Option Grant (%)

ΔPPS/PPS

K = 10 %

K = 20 %

K = 30 %

Exercise price
(assuming current share price = £30)
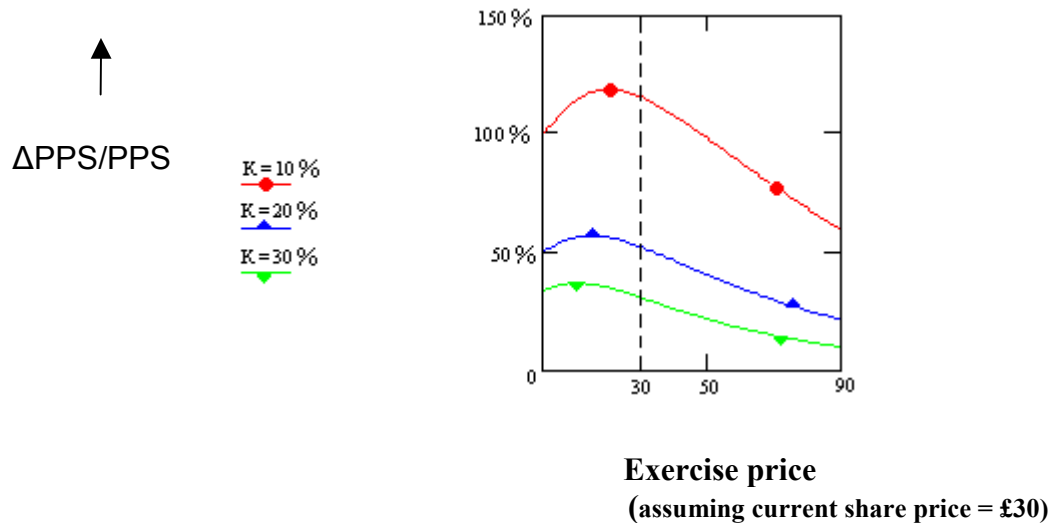
Given a share price of £30, the exercise price at which each of these loci of the percentage change in the pay-performance sensitivity as a consequence of the adoption of the option package has its maximum at £20.70 (69% of share price) when k=10%, at £15.30 (51% of share price) when k=20%, and at £10.40 (35% of share price) when k=30%. It is worth noting that these values are very close to the corresponding values in Figure 1. Therefore, as far as PPS is concerned, these conclusions reflect those of Lambert et al. (1991) and Hall and Murphy (2002). Extending this line of analysis below, we obtain a new view of the effect of options on CEOs' risk preferences, as will be seen later in Figure 4.

The value of the impact measure, ΔPPS/PPS, of a tranche of share options when the exercise price is equal to the prevailing market price of £30 can be seen in Figure 3 to be 115% (when k=10%), 52% (k=20%), and 30% (k=30%). It is also worth noting that the maxima in terms of PPS in these diagrams therefore always occur when the options in question are 'in-the-money'. This goes against the common perception that options

should be issued with challenging exercise prices and performance hurdles, and confirms the analysis of Hall and Murphy (2002).

Figure 4 plots the impact on the reward-risk trade-off ($\Delta RR/RR$) as a consequence of adopting the options package. This calculation uses the result in equation (13). Figure 4, then, represents the effect of the option grant on the executive's attitude to risk. Remembering that we define executive conservatism in risk-taking as the price increase that keeps the executive's valuation of the total pay package unchanged after a certain increase in share price volatility (the reward-risk trade off, or RR), Figure 4 plots the percentage change in executive conservatism as a result of the option grant.

Figure 4
Effect of Option Grant on the Executive's Attitude to Risk
(Resulting change in executive conservatism in risk-taking) (%)

Exercise price
(assuming current share price = £30)
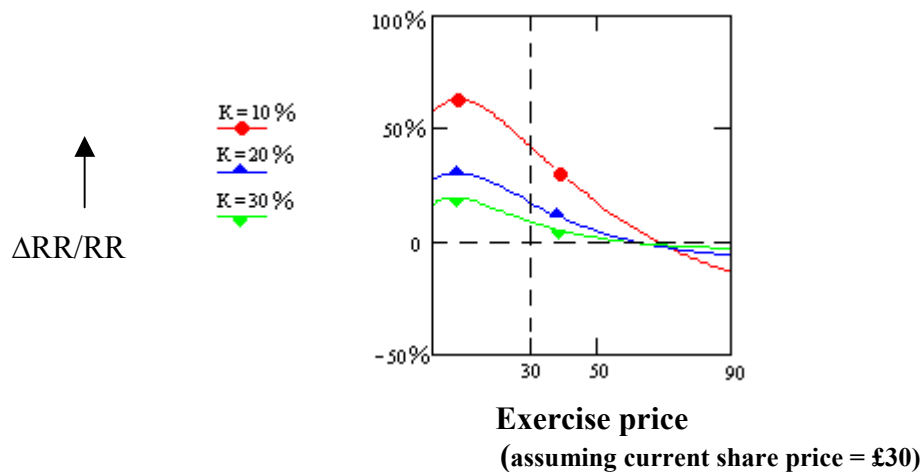
From Figure 4, it can be seen that, with a fixed share price, the exercise price at which the impact on the risk reward trade off is highest is £7.90 (62% of share price) for k=10%, £7.30 (31% of share price) for k=20%, and £6.70 (19% of share price) for k=30%. Furthermore, when the options in question are granted 'at-the-money' (i.e., exercise price is equal to £30), the impact on the risk reward trade off ($\Delta RR/RR$) is 26% (when k=10%), 24% (k=20%), and 22% (k=30%).

Furthermore, in terms of Figure 4, the exercise price at which there is no shift of attitude to risk ($\Delta RR/RR = 0$) is £70 (233% of share price) for k=10%, £64 (213% of share price) for k=20%, and £61 (203% of share price) for k=30%. All of these are, of course, well 'out of the money'.

Figure 4 also shows in fact that *all* in-the-money and at-the-money options increase executive conservatism rather than decreasing it, as commonly believed. Moreover, because of the assumed managerial risk-aversion, in-the-money options induce more conservative attitudes to risk than restricted shares ($X = 0$) with the same Black-Scholes value. As can be seen, for the option grant to reduce excessively cautious executive behaviour, exercise price should be much higher than the current share price (about twice as high as share price under our assumptions). Under most executive option schemes, however, options have been granted at-the-money. Therefore, the model suggests that the majority of modern option schemes do nothing to tackle the cautious behaviour of top managers and, if anything, cause them to be even more cautious. This theoretical conclusion corresponds with the empirical finding of Wiseman et al. (2001) of a negative relationship between share option grants and firm risk.

We now turn to empirical estimates of the various effects analysed above.

3. Results

Using data collected for 1997/98 on companies in the FTSE350 (see Buck et al., 2003), estimates are computed for each of the 204 non-financial companies that were found to be operating an active ESO scheme[9]. The key executive is the CEO, and for this person it is possible to measure base salary plus bonus pay, holdings of ESOs and holdings of other equity-related instruments such as company shares and long term incentive plans

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[9] Out of initial 350 companies, 46 financial companies and a further 70 companies not operating option schemes were excluded. A further 24 companies were dropped because of data availability arising from incidents such as de-listings and mergers. Finally, we excluded 6 more companies owing to CEO duplication in change-over periods.

(LTIPs) as recorded in the relevant 1998 company annual report. A distinctive feature of this paper is that interim valuations of ESOs and LTIPs are estimated, in the sense that they include estimates of the value of ESOs before exercise and of LTIPs before final pay-out. This produces a unique and comprehensive data set.

The Minimum Assumed Incentive Effect (MAI effect) is computed as the Black-Scholes valuation of the option holdings[10] by using equation (5) to value the certainty equivalent valuation of option holdings given the executive's other equity holdings and the level of pay[11] that is invariant with share price. The Black-Scholes valuation is then computed using equations (1) and (2) and the difference between the two valuations provides our measure of MAI effect. Further detail is available in Appendix A.

The histogram in Figure 5 describes the sample outcomes, which can be seen to cover a wide range[12], as the fraction by which the Black-Scholes value exceeds the certainty equivalent value, expressed as (B-S-cost - Risk-adjusted-value) / Base Pay.

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[10] It is well known that even if valuing the opportunity cost of ESOs to the company, the Black-Scholes formula has some limitations in the sense that the executive may leave the company, the company may be taken over and the options rendered void (unlikely in practice), there is invariably a vesting period (usually three years), and the options are non-tradable. But, for the purposes of contrasting the cost of ESOs to the company with the value of options received by executives, these complications are ignored here.

[11] This is used as a guide to the total wealth of the executive – a minimum value of £1million is ascribed. This risk-free part of the CEO's wealth, which we denote *(1-k)w*, is estimated to be the greater of £1 million or 4 times annual cash compensation. Annual cash compensation is, in turn, estimated on the basis of the company's annual report for 1997-98 as (salary + 0.8 x bonus + benefits). LTIPs and other forms of CEO holdings of the firm's shares are all included in *kw* – which is the fraction of the CEO's wealth tied up in the company shares.

[12] Note, that it is possible for this value to be negative. While this may appear perverse it merely reflects an overly diversified executive with a weakly equity–oriented portfolio, see Hall and Murphy (2002, p8).

Figure 5. Minimum assumed incentive effect of FTSE350 CEO's options in 1997/98 (Histogram)
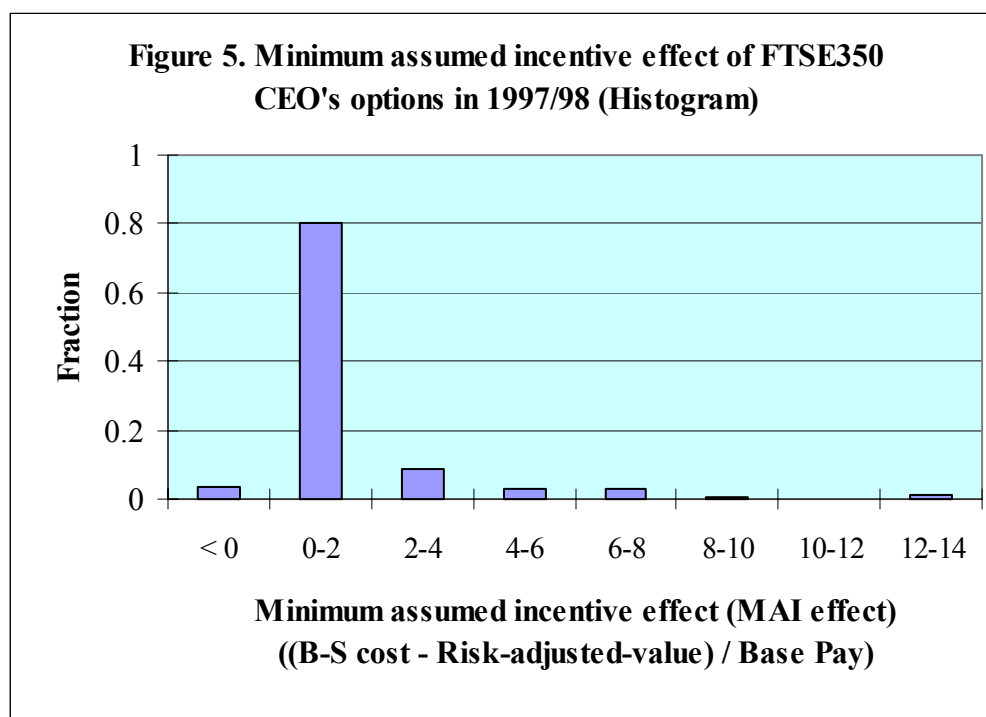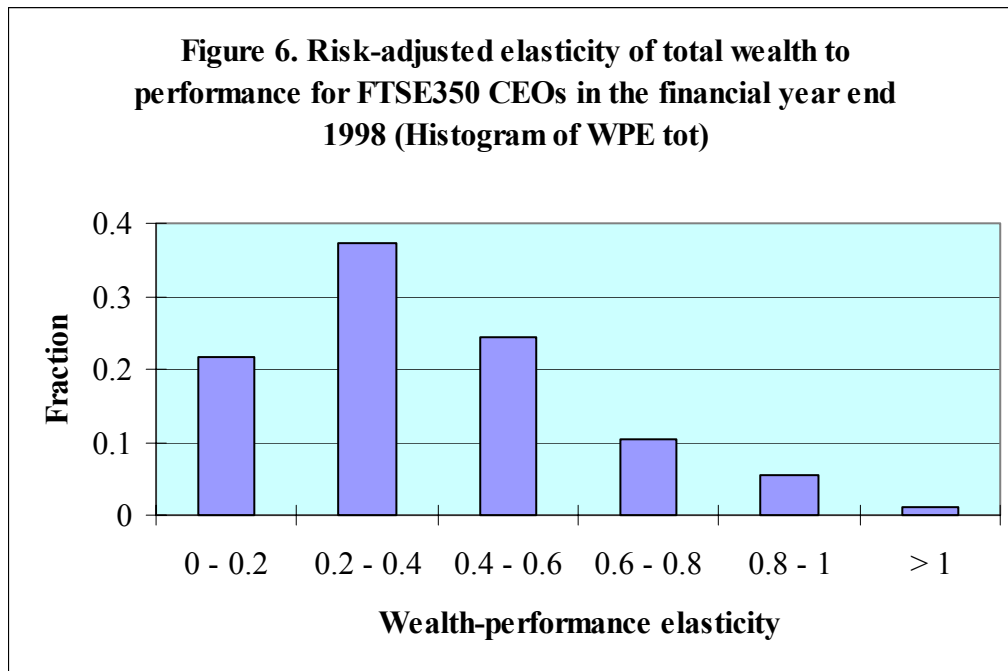

The mean value is 1.22, which suggests that the average minimum assumed incentive effect (MAI effect) is some 122% of base salary. Some 90% of observations lie between 0.1% and 575% and the median value is 48%. With very high values[13] of the MAI effect, it is clear that the company expects the incentive alignment effect to produce substantial gains in terms of shareholder value. Figure 5 assumes that all managers have the same level of risk-aversion ($\rho = 4$), which is evidently a simplification of reality. If we allow for different levels of risk-aversion among managers it would probably result in higher peaks and fewer outliers in Figure 5 because of managerial turnover and the self-selection properties of the labour market.

The risk-adjusted Wealth-Performance-Elasticity (WPE), is calculated[14] using the wealth

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[13] There were four CEOs with values in excess of 700%, namely, Ashtead, Corporate Services, Sage, and Rentokil Initial

[14] To be specific, Figure 6 plots [WPS * share price / annual cash compensation] and represents

performance sensitivity from equation (12) and is shown in Figure 6. This indicates a substantial range of values calculated for our sample of CEOs. The mean value of the WPE shown here is 0.39, with 90% of values falling in the range 0.09 to 0.83. Thus, the median value is 0.33. The wealth of the median CEO increases by 0.33% for every 1.00% increase in share price. It would appear, therefore, that for most executives in this sample, the sensitivity of remuneration to company performance is more modest than one might have expected, although there are some notable outliers[15]. At the median, the result is consistent with that found in the landmark study by Conyon and Murphy (2000, p658), which reported a median elasticity of 0.25 for the UK.
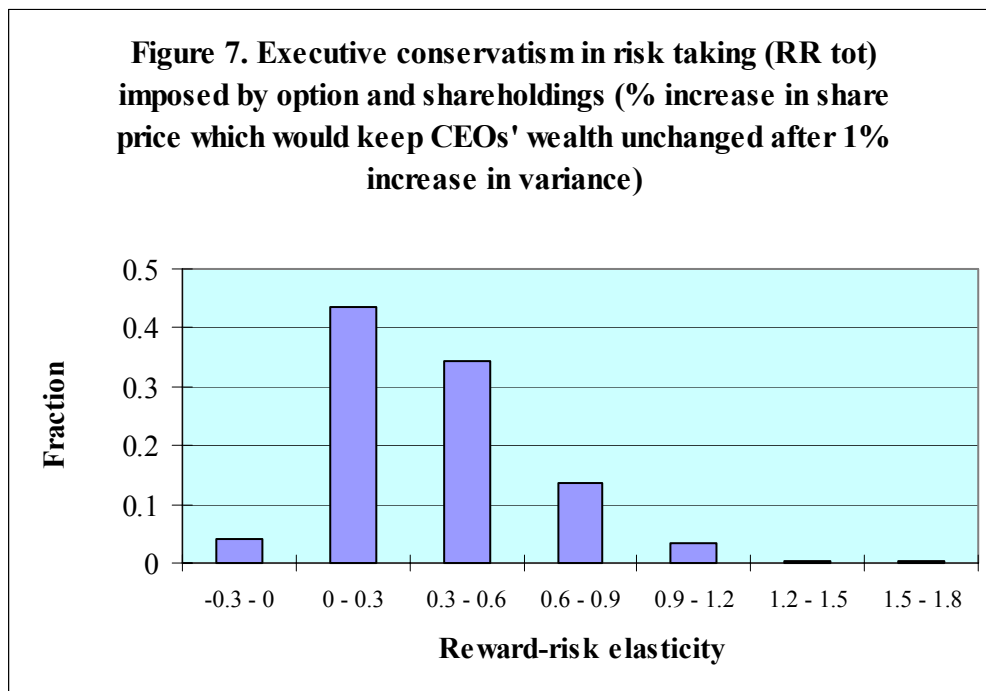

Figure 6. Risk-adjusted elasticity of total wealth to performance for FTSE350 CEOs in the financial year end 1998 (Histogram of WPE tot)

(Histogram of WPE $_{tot}$ = $(\dfrac{\partial V_{tot}}{\partial P}\dfrac{P}{V_{tot}})$)

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wealth-performance elasticity. WPS is computed based on equation (10) at the end of 1997/98 financial year. Figure 6 is a histogram of: $(\dfrac{\partial V_{tot}}{\partial P}\dfrac{P}{V_{tot}})$

[15] There are two companies with WPE greater then 1: Pillar Property, with CEO P. Vaughan, and Shell Transport and Trading, with CEO and Chairman M. Moody-Stuart. Among those with WPE close to 1 are founders of their companies or CEOs with significant shareholdings and low share price volatility: K Morrison, CEO and Chairman of Morrison (WM) Supermarket, P. Walker, CEO of Sage, and N. Wray, CEO and Chairman of Burford Holdings.

The Reward-Risk trade-off (RR) computes the percentage increase in share price necessary to compensate the executive for a 1 % increase in risk (as measured by the variance in share price) and is shown in Figure 7.   Figure 7 plots RR elasticity, where RR is computed based on equation (13), at the end of the 1997/98 financial year[16]. Therefore, Figure 7 represents RR for options in elasticity terms (percentage increase of share price that would off-set 1% increase in variance).

Figure 7. Executive conservatism in risk taking (RR tot) imposed by option and shareholdings (% increase in share price which would keep CEOs' wealth unchanged after 1% increase in variance)

The mean RR value is 0.37 with 90% of values lying between 0.02 and 0.87. It is interesting to note that there are nine CEOs with negative estimated values in Figure 7. These are the CEOs whose risk-adjusted valuation of options increases in value if

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[16] Figure 7 is a histogram of: $\dfrac{\sigma^2}{P}\dfrac{\partial P}{\partial \sigma^2}\{VS = const\} = -\dfrac{\sigma^2}{P}\dfrac{\dfrac{\partial VS}{\partial \sigma^2}}{\dfrac{\partial VS}{\partial P}}$

uncertainty grows. For the rest of the sample, the risk-adjusted valuation of options decreases with share price volatility. The median value is 0.32, which suggests that CEOs do not require particularly large relative improvements in share price to compensate for taking additional risk - a 0.32% increase in share price to compensate for a 1.00% increase in variance at the median.
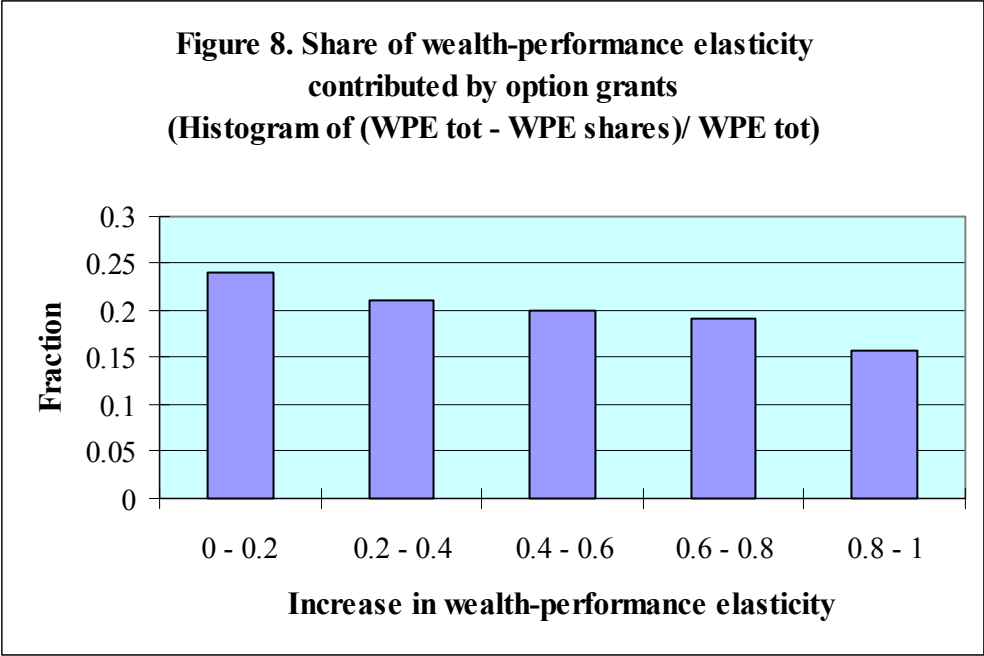
The person with the maximum relative RR of options is BTG's CEO, Mr. I. Harvey. He has an estimated relative RR of 1.77 which means that a 1.77% increase in share price is necessary to maintain the value of his options for every 1.00% increase in variance[17].

Figures 5 through 7 are informative and suggest a wide range of practice in pay design and resulting MAI effects across UK companies. It is particularly interesting to note, in Figure 7, that the overwhelming effect of share option schemes is to discourage the taking of risk by CEOs as it indicates that a predominantly positive increase in share price is necessary to off-set a one percent increase in the variance if share price. This is investigated further in Figure 9 and in Tables 1 and 2 below.

In an attempt to bring out the impact of the options packages on CEO incentives, we now examine the change in WPE (Figure 8) and the change in the RR sensitivity (Figure 9) that can be ascribed to the ESO packages the executives are seen to be holding.

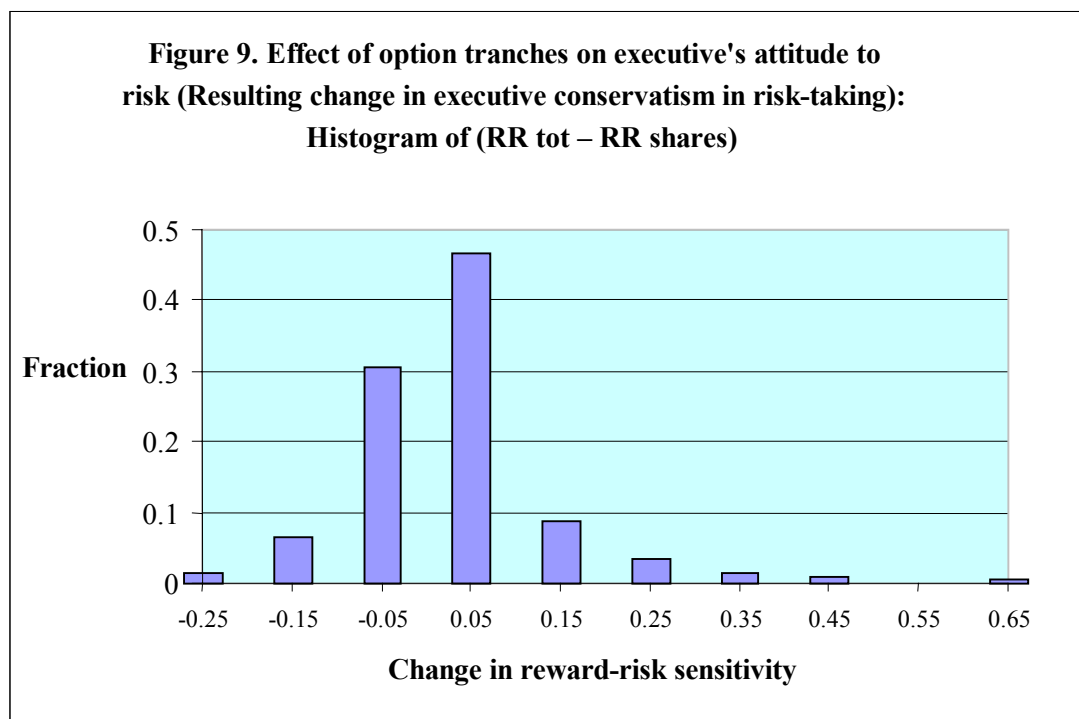[17] At BTG, CEO Mr. I. Harvey in 1998 enjoyed: Base pay of £194,123; 567,633 shares at £6.755 each; options with a B-S cost of £394,000, and a risk-adjusted value of £18,000. We see that he discounts his option holdings almost by a factor of 22 according to our model, which could obviously mean that he perceives a great risk burden. Unsurprisingly, BTG share price standard deviation is 0.58 and is among the highest in the sample.

**Figure 8. Share of wealth-performance elasticity
contributed by option grants
(Histogram of (WPE tot - WPE shares)/ WPE tot)**

Using the expression derived in equation (12) for the impact of the option package on wealth-performance sensitivity, Figure 8 illustrates the impact of observed holdings of ESOs on the CEOs in the sample. From Figure 8, the mean value is 0.45 (the median is also 0.45), with 90% of observations falling between 0.02 and 0.90. Thus, on average, option grants contribute 45% of total wealth-performance sensitivity, and 90% of observed holdings of option contribute between 2.1% and 90% of WPE. The remainder comes form holding equity and LTIPs.

Figure 9 uses equation (13) to present the impact of observed option packages on the sensitivity of the executive to embrace company risk. This is measured here by providing the difference between the estimate of what the required price/volatility trade-off is with the option package present net of what it would be were that package to be absent. A positive value therefore suggests that the option package is causing executives to be more sensitive to company risk. As can be seen in Figure 9, the mean value is 0.03 (the median is 0.02), with 90% of values falling between –0.12 and 0.23. This means that, on average, option grants increase managerial conservatism in risk taking by an additional 0.03 which constitutes roughly one-tenth of the median managerial conservatism of 0.32. However, in 78 cases out of an observed 204, those 38.2% of the sample who lie to the left of zero in Figure 9, the value of ($RR_{tot} - RR_{shares}$) is negative and total option grants actually manage to decrease managerial conservatism in investment appraisals.

The 126 cases, where options seem to provide an additional risk burden and provide an additional incentive to make cautious executive decisions, support the views of both Lambert et al. (1991) and Carpenter (2000). That said, however, for some CEOs (the 78 out of 204 who lie to the left of zero in Figure 9) there is support for the view of Agrawal and Mandelker (1987) and DeFusco et al. (1990) that ESOs promote corporate risk-taking behaviour.

Figure 9. Effect of option tranches on executive's attitude to risk (Resulting change in executive conservatism in risk-taking): Histogram of (RR tot – RR shares)

Further detail is provided in Tables 1 and 2. These summarise, by quartile, the various incentive effects of the equity components of executive pay as recorded in the sample of CEOs taken from the FTSE350 companies. We concentrate on Table 1, which divides the sample by the relative importance of the assumed incentive effect of ESOs expressed as a fraction of base pay. Table 2 repeats this analysis but defines the quartiles in terms of the opportunity cost of the option package (at Black-Scholes values).

In Table 1, column 3 is based on equation (1) and indicates the spread of the cost of the options packages being held. These vary from the low-quartile value of £103k to the upper quartile value of £1,983k. The corresponding risk-adjusted values are given in column 4 (from equation 5) and range from £75k to £563k respectively. More importantly, column 5 reports the wealth-performance elasticities, and column 6 describes the percentage of this attributable to ESOs. The relative importance of ESOs is around 36% to 53%, with the rest of the incentive effect coming from executives' shareholdings and LTIP schemes. But the size of the effect, reflecting the absolute level of use of these components, varies widely. At the upper quartile, some £1,983k of equity instruments are held with an effective certainty equivalent value of £563k, this leaving an implied £1,420k of value to be produced by the incentive effect. The corresponding risk-adjusted wealth-performance elasticity is 0.62.

Column 7 reports the median values of the reward-risk trade-off, and shows that, with a move to a higher assumed incentive effect (generally, executives with a heavier preponderance of options and equity in their remuneration package), the required share price appreciation in return for higher volatility increases. Furthermore, Column 8 indicates that only in the bottom quartile does the equity aspect of the remuneration package induce risk-taking behaviour, in the sense that immediately exercising all option holdings would increase the CEO's risk burden and would leave the CEO's wealth more vulnerable to market uncertainty. Hence, only for CEOs in the bottom quartile do options moderate conservatism in risk taking. In the other three quartiles, the presence of

executive share options increases the required share appreciation in return for higher assumption of risk (makes them more conservative). This result is obtained by using equations (11) and (13) respectively before and after the assumption that all options have been exercised and sold. Column 8 then compares the price-risk trade-off with and without options through the ratio: $(RR_{shares\ only} - RR_{tot})/(RR_{tot})$.

Table 3 reports the results of a simple regression that explores two hypotheses. The first hypothesis is that company costs associated with ESO grants are, at least in part, paid off by enhanced future performance of the company brought about by improved alignment in managerial incentives. The second hypothesis relates to the relationship between the extent of executive conservatism and the firm's *future* performance. It is argued here that excessively cautious executives may negatively affect company performance. In order to test for these hypotheses, a one-year lag was assumed. the industry-adjusted total shareholder returns were collected for the year (1998/99) following the incentive pay valuations and regressed on our measures of the MAI effect (as in Figure 5) and executive conservatism (RR_{shares}, as in Figure 7) both measured at 1997/98.

Table 3 suggests that controlling for the risk conservatism effect, the more faith companies have in ESOs (as manifested by a higher MAI effect) the more positive is subsequent company performance. This lends support to our first hypothesis.

The statistically significant negative estimate for the relationship between executive conservatism (RR) and subsequent total shareholder return, reported in Table 3, is consistent with our second hypothesis. Executives whose remuneration packages incline them to place a high price on additional company risk, are associated with poorer company performance in the subsequent period. Thus, the empirical results tentatively suggest that relatively cautious executives negatively affect company performance.

4. Discussion

Company executives are argued to be relatively undiversified, especially since boards usually impose significant ownership requirements on executives in line with the conventional wisdom of aligning the interests of managers with those of shareholders. To keep executives' rewards dependent on company share price, various time restrictions on hedging company shares and trading in such options generally apply to executive pay packages. As a result, it is not only the human capital of managers (including reputation in the managerial labour market, see Fama (1980)) that is heavily dependent on company performance, but much of their financial capital as well. Under these circumstances, risk-averse managers are sometimes argued to be more conservative with respect to risk-taking than well-diversified outside shareholders would prefer them to be.

Nevertheless, it is often assumed that option grants increase managerial risk-taking since they reward share price appreciation in full and impose only limited, albeit non-trivial, penalties for falling share price. However, there is only weak support for this logic from empirical studies. Indeed, Wiseman et al. (2001) find a negative relationship between the share option wealth of CEOs and measures of firm risk. A possible explanation is that options deep in-the-money lose their risk-inducing potential and converge on shares from the incentive property perspective. More generally, as Hall and Murphy (2002) point out, even options granted at-the-money may have a negative effect on risk-taking if the executive is heavily undiversified. It is argued here that the effect of option grants on managerial attitudes to risk needs more careful analysis in order to derive implications for the design of ESO plans.

The results reported above lend some support to those who suggest that option grants do not decrease conservatism in risk taking, with the majority of CEOs in our FTSE350 sample (126 out of 204) being in a situation where options, and certainly additional options, seem to provide an additional risk burden and hence induce further cautious behaviour as suggested by both Lambert et al. (1991) and Carpenter (2000).   On the other hand, for some CEOs (78 out of 204) there is support for the view of Agrawal and

Mandelker (1987) and DeFusco et al. (1990) that ESOs promote corporate risk-taking behaviour. At the very least, the evidence presented above seems to support the view of Yermack (1995) that option policy is not always well thought out or planned by companies in terms of tackling agency problems. That said, however, the results presented here can be encompassed by the approach of Core and Guay (1999), who use an optimising framework but allow for transitory out of equilibrium positions to arise.

What does emerge clearly in the basic regression of Table 3 is that there are indications that companies that place their faith in the incentive effect of ESOs do reap the reward of higher company performance. Those companies where executives had options packages with a higher minimum assumed incentive effect (MAI effect) in 1997/98, as measured as a proportion of their base pay, were indeed seen to record higher industry-adjusted shareholder returns in the following financial year. On the other hand, companies where executives held a higher price on risk were associated with lower shareholder return in the following year.

In terms of the MAI effect itself, Figure 5 shows that some 80% of firms are operating in the range of up to two times base pay. The wealth to performance elasticity in the sample of 204 firms is shown in Figure 6, and has a median value of 0.33, slightly higher but consistent with the Conyon and Murphy (2000) result of 0.25. Figure 7 shows that, for almost all executives in the sample, additional ESOs could induce less rather than more risk taking in their company decisions. This is balanced somewhat, by the results of Figure 9 where it can be seen that the option package as a whole has the effect of reducing the barriers to risk taking (at least in 78 of the 204 executives examined). For the remaining 126 executives, however, the executive share options move the executives to a more conservative position.

The analysis presented above develops and extends the work of Lambert et al. (1991) and of Hall and Murphy (2002). Possible future extensions would involve considering the effect of the option grant on the total pay package over the whole option term rather than simply looking, as above, at its impact in a single cross section of data. The expected

trajectory of share prices introduces expectations into the executive's valuation of options in years 2,..,T as well as expectations of incentives that can be different from incentives at year 1. It would be rational for the company, therefore, to include these expectations in its considerations and to solve the problem of incentive optimisation not just at the time of the grant but for the whole option term. But, even within the confines of the present analysis, it is felt that this approach through the MAI effect offers insights to executive pay that have previously eluded analysis.

Appendix A

One complication confronted in the data is the fact that individual CEOs in the data collected as at 1998 have up to six different option tranches. A literal implementation of the theory developed above would lead to six-fold integrals, and the consequent empirical calculations would be prohibitively time consuming. To simplify matters, a degree of aggregation is undertaken.

In aggregating, however, it is necessary to recognise that one should not aggregate two very different (with respect to time to maturity) option tranches. For example, the risk - adjusted valuation of a one 1-year option and a 9-year option (both of the same exercise price) is not equal to the risk adjusted valuation of two 5-year options, because of different degrees of uncertainty attached to these options. The effective 'discount rate' which risk-averse recipients apply to options varies with the option term and this effect is further complicated due to the essential nonlinearity of the utility function.

In order to minimise any possible aggregation errors while maintaining computational tractability, for individual CEOs we aggregate all their option tranches into two groups, with time to maturity T1 and T2, T1< T2. We assume that executives lock in all of the realised gain of the shorter option grant at the expiration moment T1 and enjoy the risk-free interest rate 'r' on this gain for the remainder of the period (T2-T1). With two option tranches the analysis is as follows.

Assuming an initial wealth of w, the executive's wealth at time T2 can be modelled as:

$$W_{T_2} = W_{T_2}(P_0, P_{T_1}, P_{T_2}, m_1, m_2, k, X_1, X_2) =$$

$$= (1-k)w(1+r)^{T_2} + kw\frac{P_{T_2}}{P_0} + (1+r)^{T_2-T_1} m_1 \max(0, P_{T_1} - X_1) + m_2 \max(0, P_{T_2} - X_2)$$

where:

P_0, P_{T1}, P_{T2} – realised share price at time 0, T_1, T_2;
T_1, T_2 – terms of two option grants $T_1 < T_2$;
m_1, m_2 – correspondent quantity of options in the option grants;
X_1, X_2 – exercise price of options of the first and second grant correspondingly.

As mentioned above, the form of W_{T2} assumes that the executive locks in all of the realised gain of the shorter option grant at the expiration moment T_1 and enjoys risk-free interest rate r on this gain for the rest of the period $(T_2\text{-}T_1)$. As before, the award of riskless bonds V instead of options would leave the executive with wealth:

$$W_{T_2}^V = W_{T_2}^V(P_0, P_{T_2}, k, V) = ((1-k)w + V)(1+r)^{T_2} + kw\frac{P_{T_2}}{P_0}$$

Expectations of W_{T_2} and $W_{T_2}^V$ are given correspondingly by:

$$LHS = \int_0^\infty \left(\int_0^\infty U(W_{T_2}(P_0, P_{T_1}, P_{T_2}, m_1, m_2, k, X_1, X_2)) f(P_{T_2} | P_{T_1}) dP_{T_2} \right) f(P_{T_1} | P_0) dP_{T_1}$$

$$RHS = \int_0^\infty U(W_{T_2}^V(P_0, P_{T_2}, k, VS)) f(P_{T_2} | P_0) dP_{T_2}$$

The numerical solution of equation LHS = RHS for VS gives the executive's valuation of the option grant as represented by the two tranches.

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Table 1.
Risk-adjusted Incentives and Minimum Assumed Incentive Effect

(1) Minimum assumed incentive effect MAIE = (B-S value – risk-adj. Value) / Base pay	(2) N Obs.	(3) Median B-S value £ thousands	(4) Median risk-adjusted option value £ thousands	(5) Median risk-adjusted wealth-performance elasticity (WPE) (for a whole sample histogram, see Figure 6)	(6) Part of WPE generated by option holdings (median value) (for a whole sample histogram, see Figure 8)	(7) Median risk-reward trade-off of CEO's total wealth (RR) (for a whole sample histogram, see Figure 7)	(8) Relative effect of exercising and selling all options holdings on RR (median value)
MAIE < 0.166 (low company cost)	51	103	75	0.18	53 %	0.11	+ 10.0 %
0.166 < MAIE < 0.482	51	313	184	0.33	50 %	0.26	- 6.4 %
0.482 < MAIE <1.170	51	613	240	0.37	42 %	0.38	-11.5 %
MAIE > 1.170 (high company cost)	51	1,983	563	0.62	36 %	0.55	-7.0 %

TABLES 1 and 2 notes:

Where:

Column

1. variable used to create the quartiles

2. number of observations falling within each quartile

3. median B-S value of option grants held by executive, in £ thousands

4. median risk-adjusted value of option grants, in £ thousands

5. median risk-adjusted wealth-performance elasticity (WPE) of all holdings (shares + options)Example: in the fourth quartile in the Table 1, WPE = 0.62 which means that median CEO's wealth of these firms grows by 0.62% with every 1% increase in share price the fraction of the WPE that is generated by option holdings

6. relative effect of exercising option holdings on WPE.

7. median risk-reward (RR) trade-off of the CEOs' total wealth imposed by share- and option holdings. Serves as a proxy for the CEO's conservatism in risk-taking. Example: in the fourth quartile in Table 1, RR = 0.55 means that the negative effect of a 1% increase in share price variance on the CEOs' total wealth can be off-set by 0.55 % increase in share price.

8. Relative effect of exercising option holdings on RR. If this figure is positive, the ESOs act to reduce the CEO's conservatism in risk-taking.

Table 2.
Risk-adjusted Incentives and the Company Opportunity Cost of Options

(1) Company opportunity cost of options = B-S value – risk-adj. value	(2) N Obs.	(3) Median B-S value £ thousands	(4) Median risk-adjusted option value £ thousands	(5) Median risk-adjusted wealth-performance elasticity (WPE) (for a whole sample histogram, see Figure 6)	(6) Part of WPE generated by option holdings (median value) (for a whole sample histogram, see Figure 8)	(7) Median risk-reward trade-off of CEOs' total wealth (RR) (for a whole sample histogram, see Figure 7)	(8) Relative effect of exercising and selling all options holdings on RR (median value)
Cost < £65,000 (low company cost)	51	90	62	0.18	52 %	0.12	+5.0 %
£65,000 < Cost < £202,500	51	296	207	0.34	46 %	0.24	-7.0 %
£202,500 < Cost <£519,000	51	595	211	0.36	45 %	0.38	-10.8 %
Cost >£519,000 (high company cost)	51	2,175	680	0.62	41 %	0.55	-11.7 %

Table 3

Explanatory Regression for Next Year's Industry-Adjusted Total Shareholder Return

(t-statistics in parentheses)

Dependent variable = Industry-adjusted TSR for 1998/99 fiscal year	
Independent variables (1997/98):	Estimated coefficient (t-statistic)
MAI EFFECT	0.038 (2.58)**
Rate of executive conservatism (RR_{shares})	-0.317 (3.21)**
Constant	0.036 (1.00)
F(2,201) statistic/ prob. Value	6.14 (0.003)
Adj. R^2	.06
Mean of dependent variable	-.0248
N Obs.	204