Executive stock options: volatility, managerial decisions and agency costs

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Abstract

This paper proposes a new rationale for understanding managerial contracts which set-out to induce stock price volatility in the form of granting of executive stock options. First, we suggest that previous research focuses too much on short term volatility effects and offering neither a theoretical or empirical perspective on incentives which might influence long-term behaviour. To address this, we offer a theoretical structure of why managerial incentives might be important in determining the evolution of volatility over the life of an option contract and provide empirical support for our views. Second, we examine the impact of option moneyness on managerial behaviour over time and provide an analysis, with supporting empirical work, of the unintended incentives thereby created. Our approach suggests that volatility-inducing contracts do not work in the intended manner and supports a growing body of work which indicates that option-based remuneration does not incentivise managers to enhance corporate performance. Our evidence is within a UK context, based on a near-population sample size. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Executive stock option schemes have been identified as a means of reducing the agency problems which exist between managers and stockholders and have now

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become a popular component of managerial compensation packages (Pavlik et al., 1993). However, researchers have found it difficult to identify an appropriate measure of the performance incentives provided by option-based remuneration contracts and cannot, therefore, unequivocally ascribe changes in corporate performance to the granting of options (Yermack, 1995). The purpose of this paper is not to replicate studies which associate the existence of option-based remuneration with general aspects of corporate performance (mostly, in terms of firm value as in Smith and Watts, 1992; Gaver and Gaver, 1993; Matsunga, 1995; Main et al., 1996; Yermack, 1998, for example). Instead, we aim to provide a theoretically consistent framework which might provide an important perspective on corporate return volatility, as one measure of corporate performance, and offer an explanation for the pattern of volatility that subsequently emerges. In undertaking this task we draw a distinction between short and long-term volatility effects which can arise for different reasons. The identification of a volatility effect, per se, is not new since studies relating option granting and volatility are numerous (eg. Amihud and Lev, 1981; Brickley et al., 1985; Agrawal and Mandelker, 1987; DeFusco et al., 1990; John and John, 1993; Mehran, 1995), but our departure from previous work is to demonstrate that the existing perspective is possibly too restrictive in its view of appropriate temporal effects and not sufficiently underpinned by a theoretical structure which explains management incentives over the life of the option contract.

In analysing the effects of the granting of stock options empirical studies have been concerned with two broad themes. Firstly, with the investigation of whether positive abnormal stock price returns are observed following the announcement of executive options and other incentive plans (the ‘price’ effect) and, secondly, with the question of whether stock price returns exhibit greater volatility following the approval of an executive stock option scheme (the ‘volatility’ effect).

The first of these types of study has examined the notion that stock prices will respond positively to an unexpected announcement of the granting of stock options (Executive Stock Options Schemes, or ESOS) due to, inter alia, reduced agency costs from improved incentives, favourable signals of future performance, and shared taxation benefits. The second type of study has focused on the idea that agency costs are created by the excessive risk aversion of managers compared to stockholders (Amihud and Lev, 1981). Managers’ exposure to risk is altered by ESOS because of the asymmetric payoffs which provide downside protection for managers inducing them to undertake higher risk projects than would otherwise be the case. The reason why this may come about derives from the Black and Scholes (1973) option pricing model which argues that the value of call options increases as stock price volatility increases. In the context of executive stock options this would provide an incentive for managers to increase the variability of equity returns either by accepting riskier projects and/or by increasing the level of financial leverage of the company. The consequences of such risk-inducing contracts has been widely held to provide managers with an incentive to shift wealth from bondholders to stockholders (Jensen and Meckling, 1976). Haugen and Sennet (1981) developed the Jensen–Meckling framework arguing analytically that executive options may cause managers to take on more risk and can play an important role in reducing agency problems associated with external financing.
The nature of the methodology in investigating volatility effects has been to establish empirically whether there has been a significant difference in stock price volatility in the period after the issue of ESOS, compared to the period prior to issue, and to examine wealth transfer effects between stockholders and bondholders. Other empirical tests have investigated whether stock prices exhibit greater volatility following the issue of executive options in relation to a comparable period prior to such an issue and whether, as a response to the increased volatility, bond prices have fallen. For example, Agrawal and Mandelker (1987) argued that where management compensation contracts were in the form of options and were significant, managers will select variance increasing corporate investments. They used data for up to days -120 and +120 around the announcement date and their findings supported their hypothesis. Thus, they concluded that executive option schemes had a role in decreasing managerial incentive problems arising from excessive risk aversion. DeFusco et al. (1990) found an increase in stock return variance and the implied variance of traded stock options. They used monthly and daily data, for intervals of up to 24 months and 500 days, respectively, before and after the announcement of a change in option plan. Additionally, they found a significant positive stock price reaction and a significant negative bond price reaction to the issue of executive options. This evidence is consistent with the notion that such plans may induce a transfer of wealth from bondholders to stockholders and is therefore supportive of the incentive/agency hypothesis. Gucseli and Ho (1993) attempted to test empirically the risk-taking and wealth-transfer effects of ESOS in the UK. They failed, however, to find either a significant stock price or bond price reaction. Nevertheless, they did report a significant increase in market adjusted stock price volatility for the 250 day and 500 day periods following the issue of executive options but failed to find any significant increase in volatility in the 700 day period following issue.

This paper also focuses mainly upon investigating the changing volatility of stock prices in response to the issuing of new ESOS. In so doing, however, it argues that the existing literature has been inappropriately restrictive by examining only the period immediately following the issue of ESOS, thereby failing to consider the intertemporal changes in the incentives for managers to take risks over the life of an option contract. Specifically, it argues that the asymmetric nature of the payoffs from executive options is reduced over time as the underlying stock price rises and the option is expected to become increasingly in-the-money. Hence, managers are not totally immune to downside risk as the temporal effect takes-over. Our aim, therefore, is to, first, set out our analytical framework which we propose is driven by volatility and show how this might alter with the passage of time and, second, to provide evidence to indicate that option moneyness undermines the intended incentives put in place by option-based contracts. The remainder of the paper is thus organised as follows. The analytical framework is outlined in Section 2, while Section 3 discusses the methodology. Section 4 presents the sources of the data and sample details, results are reported in Section 5 and the potential impact of leverage effects is examined in Section 6. In Section 7 conclusions are then drawn.
2. Analytical framework

It has been argued (Agrawal and Mandelker, 1987) that the total wealth, \( W \), of a manager may be divided into three main categories: stock and option holdings in the employing company, \( W_s \); human capital, representing the present value of future employment earnings, \( W_h \); and other assets unrelated to the firm, \( W_o \). If \( W_s \) and \( W_o \) are small then managers’ corporate investment and financing decisions are likely to be influenced by their impact on human capital. Specifically, if the firm performs badly, three effects on human capital have been argued to arise: first, current remuneration falls, (Murphy, 1985); second, potential earnings in alternative employment fall (Amihud and Lev, 1981); and third, if the firm fails, then firm specific human capital is lost. Thus, to the extent that managers’ human capital is correlated with changes in firm value, decisions which increase the variance of returns will increase the variability of human capital. Given a degree of risk aversion in managers, there are incentives for managers to select variance decreasing investments and forms of financing. If \( W_s \) is significant relative to \( W_h \) the traditional analysis becomes less clear. To the extent that \( W_s \) consists of executive options, it is traditionally argued that the asymmetric payoffs providing downside protection for managers make it more likely they will undertake risky investments and forms of financing. The justification lies within the Black–Scholes model which argues that the value of this call option is an increasing function of the variance of cash flows. Given this, \( W_s \) provides an incentive for managers to increase risk and \( W_h \) an incentive to reduce risk. Thus, the net effect is an empirical question, depending on a variety of variables including the degree of risk aversion of managers and the respective proportions of wealth in human capital and options. The issuing of executive options, per se, does not therefore make managers risk-seeking. Rather, at the margin, they are argued to have a greater propensity to take risky decisions than would have been the case in the absence of such options.

Our extension of this framework involves an examination of the dynamics of managerial behaviour to changing conditions which can alter response to continued ownership of stock options. In other words, we argue that the proportions of \( W_s \) and \( W_h \) to \( W \) alter with the passage of time in a way that leads to testable hypotheses concerning managerial response, option holding and risk behaviour. This is a departure from traditional analysis because existing work considers only the initial impact of issuing options on the decisions of managers. Specifically, evidence in existing work has failed to establish increased volatility beyond two years after the granting of ESOS. Yet, such option contracts are still in existence with presumably the same volatility-inducing incentives for a minimum period of three years. A key unanswered question, therefore, is why-if the existing literature is correct in identifying only short-term effects-are options ineffective in altering managerial behaviour after 2 years? This paper offers an intertemporal perspective which addresses this issue and suggests how the dynamics of managerial response may alter with the passage of time. To this end, we provide an expectations-based, or ex ante, model of behaviour which is then revised, analogous to Bayesian updating, once evidence of decision outcomes is obtained. The revision of be-
haviour, as incorporated in our ex post model, then provides a rationale for potentially perverse results to arise in which managerial response can be the opposite of what is expected when options are granted. Our suggestion is, therefore, that the original intention of granting options in terms of inducing greater risk-taking is undermined by a rational response to the evolution of evidence regarding managerial/corporate performance.

2.1. Model I — the ex ante model

Commencing with a simplified and very short term model represented in Fig. 1, assume that a manager has two investment opportunities available, $H_0$ and $L_0$, where $H_0$ is high risk and $L_0$ is low risk. The decision is taken today, $t_0$. Each of the investments has an expected mean NPV of zero. Stock options are granted at-the-money, thus the exercise price, $X$, equals the current market price, $M_0$. It is assumed that the sole method of managerial remuneration is in the form of options. Finally, the outcome of the project (the NPV) becomes known immediately and options are exercised immediately.

In Fig. 1 it can be seen that managers will prefer investment $H_0$ as they do not participate in the left-hand side of the distribution, and there is greater upside potential in $H_0$ than in $L_0$. Indeed, it could be the case that even if there is a small negative NPV, and thus an expected fall in stock price, risk averse managers are still likely to prefer investment $H_0$. This is clearly dysfunctional as in this latter

![Fig. 1. Stock options are granted at the beginning of period 1 ($t_0$), at which point both the exercise price, $X$, and the market price of the stock, $M_0$ are equal. Managers prefer projects which induce greater volatility, such as in distribution $H_0$, because they participate in greater upside potential without facing any downside risk.](image-url)

\footnote{Empirical evidence also suggests that the in-the-money effect applies immediately on issue of the option. Both in the US, Yermack (1998), and in the UK, Ormrod and Brookfield (1996), it has been found that stock prices rise immediately on the announcement of an ESOS. The consequence of this is that for many companies such options become immediately in-the-money on issue, and thus executives potentially share in the downside of any decisions from the date of granting.}
Fig. 2. By period $t_3$ stock price has trended upwards from its original point at $M_0$ to $M_3$, $H_3$ and $L_3$ represent the high variance and low variance new investment opportunities, respectively, for which decisions have to be made at $t_3$. Employees holding stock options now participate in downside risk to the extent of area under the curves between $M_0$ and $M_3$ because the mean of the stock return distribution at period $t_3$ is now represented by $M_3$.

case stockholders would reject both projects, even if risk neutral. Under such circumstances we would expect, in common with other researchers, to observe an increase in the variance of returns over the life of option contracts which is the empirically observed short-term response to option-based remuneration.

2.2. Model II — the ex post model

In terms of our model outline, consider now the situation of a longer term option contract where after, say, 3 years, $t_3$, options are in-the-money, thus $M_3 > X$. This is perhaps as a result of a general upward drift in the market, the industry or indeed because of company specific manager decisions.

In Fig. 2, managers now participate in the downside risk of any decisions in that the current value of options may fall. While there is still some downside protection, where stock price falls below $M_0$, deep-in-the-money options may be of such value that if, in the extreme, they fall to zero, risk averse managers may now prefer $L_3$ to $H_3$, even though the expected value of payoffs from $H_3$ is greater. In this situation, however, such options may cease to be dysfunctional, in the sense of inducing excessive risk seeking behaviour, even if they were the sole form of remuneration (i.e. $W = W_s$). This is because, despite the positive expected value to managers from $H_3$ and $L_3$, their risk-return utility functions may be such that the downside risks, despite their protection below a zero option value, may be weighted more highly than the upside payoffs.

Our analysis rests on the particular characteristics of ESOS which gives rise to the possibility that managers can respond to increasing moneyness by reducing the risk exposure of the projects they choose. For such a situation to arise, the options managers hold must be non-tradable and non-hedgable. In the UK for the sample period chosen executive share options were not tradable since option rights were
typically tied to continued employment with the option-granting firm and had either to be exercised or allowed to lapse on resignation. Moreover, under UK tax law granting tax free status for ESOS, the legal rights were not transferable and were specific to the individual. It is conceivable that executive share option schemes could be hedged in other ways but the widespread evidence of early exercise (on average 6.6 years) and the complete lack of evidence in our sample of such transactions (which would be disclosed under the provisions of the Companies’ Act, 1985) lead us to conclude that hedging was not a feature of our sample. Support from recent literature regarding the non tradable and non hedgable nature of executive options is widely available. This has been developed using utility maximising models (for example Huddart, 1994) and also using an exogenous stopping state model (for example Carpenter, 1998).

Further evidence of the non tradable and non hedgable nature of executive options suggests that hedgability and tradability restrictions imposed by regulation are effective. In particular, managers are observed to exercise their options significantly before expiration, thereby giving up any additional time value which might have been captured by trading or hedging activities. Empirical evidence of early exercise in the US includes Cuny and Jorion (1995) and Huddart and Lang (1996). In the UK there is similar evidence, for example Income Data Services (1998). We do presume that managers are risk averse for the events described in the diagrams to materialise but ultimately leave this presumption to be resolved by the evidence which we present below. What we do say is that non-tradability and non-hedgability can give rise to the circumstances indicated. Thus, in the situation at $t_3$, three years into the option, the incentive for managers to take risks in respect of their deep in-the-money options is significantly reduced compared to $t_0$, at the grant date, where options are at-the-money and the downside protection is more immediate to current values ($X = M_0$). In this former case, far from options counter-balancing the risk aversion effects of human capital, $W_0$, they might, for deep in-the-money options, actually enhance risk aversion, given the particular sensitivity of option values to underlying market values. Paradoxically, in this situation, agency costs may be increased by an ESOS scheme as risk averse managers are tempted to become even more risk averse in an attempt to protect historical gains in their options in the face of the extreme volatility which can be exhibited by this particular financial instrument. Thus, the model of behaviour outlined in this paper would predict that, ceteris paribus, volatility would decrease over time as options became increasingly in-the-money and managers shared increasingly in the downside potential of their decisions.

The converse of the argument would also hold in that we would expect managers who might be holding out-the-money options (after a period of time has elapsed after the granting of options) to be more willing to take risky investment and financing decisions than those holding in-the-money options. As a consequence, we might observe variances increasing as a response to a situation in which managers fail to participate in option-based remuneration because of their failure to adopt projects which would produce in-the-money options. We would therefore expect increasingly risky decisions to be taken and, as a consequence, variances of returns should increase over time.
3. Methodology

The methodology outlined in Skinner (1989) and in DeFusco et al. (1990) is employed, whereby pre and post granting variances in stock returns are compared. Our approach extends this, however, to observe the nature of variances over a longer time-horizon and examines variances in discrete, rather than cumulative, post granting periods. Our time horizon for investigation is set at four years in the post-granting period divided into eight half year periods. We control for changes in market risk by standardising all variance estimates by contemporary estimates of market variance.

3.1. Model I — the ex ante model

Our conjectures outlined in model I, the ex ante model, are tested against the experience of other researchers using a unique data source and improved grant date resolution, and over a longer time horizon in order for the effects of movements in stock prices to have time to impact on the volatility of returns. The experience of other researchers is to observe an increase in volatility following the granting of options. The reference point is the pre-grant variance at which exercise prices are set and managers are then incentivised to act accordingly (by increasing the variance of returns). Our ex ante model I prediction may be summarised thus:

Test 1: The alternative hypothesis of the ex ante model is that we observe variances increasing as a response to managers being immunised to exposure from downside risk of investment decisions.

To this end, variances in stock returns over eight, 6 monthly intervals in the post-granting period are compared by reference to the pre-grant period. Previous studies usually exclude consideration of the granting period from the analysis because of possible contamination of the results due to uncertainty of the grant date. This is not the case here because we have certain knowledge of the grant date. Nevertheless, we replicate the usual approach to compare our results. Evidence is reported in Table 1.

3.2. Model II — the ex post model

The analysis of model II, the ex post model, is applied empirically by determining if an option is in- or out-the-money and whether this information has additional discriminatory power in explaining the long-term behaviour of returns volatility. Moneyness is referenced to the earliest point at which the options can be exercised (at the end of the third year) such that a company is categorised as having in-the-money options if its share price at the end of the third year is higher than that prevailing at the date of granting. Out-of-the money options are analogously defined. Based on the pattern of incentives created, as explained in terms of Model II above, we might therefore expect a decreasing evolution of variances for
### Table 1
Variance ratios following the adoption of executive stock option schemes: full sample results 1984–1995

<table>
<thead>
<tr>
<th>Period</th>
<th>Average variance</th>
<th>Ratio of post grant variance to pre-grant variance</th>
<th>Median variance</th>
<th>Maximum variance</th>
<th>Minimum variance</th>
<th>Percentage variances &gt; pre-grant variance</th>
<th>Z</th>
<th>Two-tailed signed-rank probability for variance change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre grant period</td>
<td>5.022</td>
<td></td>
<td>3.620</td>
<td>53.911</td>
<td>0.612</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st post grant period</td>
<td>5.765</td>
<td>1.147</td>
<td>4.405</td>
<td>26.830</td>
<td>0.121</td>
<td>67</td>
<td>3.375</td>
<td>0.003</td>
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<tr>
<td>2nd post grant period</td>
<td>5.543</td>
<td>1.103</td>
<td>4.293</td>
<td>22.404</td>
<td>0.976</td>
<td>62</td>
<td>3.296</td>
<td>0.007</td>
</tr>
<tr>
<td>3rd post grant period</td>
<td>5.474</td>
<td>1.090</td>
<td>3.908</td>
<td>37.707</td>
<td>0.765</td>
<td>57</td>
<td>2.566</td>
<td>0.0052</td>
</tr>
<tr>
<td>4th post grant period</td>
<td>4.553</td>
<td>0.907</td>
<td>3.319</td>
<td>35.739</td>
<td>0.786</td>
<td>52</td>
<td>-0.748</td>
<td>0.2005</td>
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<tr>
<td>5th post grant period</td>
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<td>0.878</td>
<td>2.911</td>
<td>20.341</td>
<td>0.836</td>
<td>58</td>
<td>1.156</td>
<td>0.1251</td>
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<td>6th post grant period</td>
<td>5.381</td>
<td>1.071</td>
<td>4.048</td>
<td>31.447</td>
<td>0.440</td>
<td>64</td>
<td>2.826</td>
<td>0.0024</td>
</tr>
<tr>
<td>7th post grant period</td>
<td>5.882</td>
<td>1.171</td>
<td>5.148</td>
<td>23.944</td>
<td>0.036</td>
<td>64</td>
<td>2.635</td>
<td>0.0043</td>
</tr>
<tr>
<td>8th post grant period</td>
<td>6.636</td>
<td>1.321</td>
<td>3.393</td>
<td>35.815</td>
<td>0.866</td>
<td>63</td>
<td>2.001</td>
<td>0.0228</td>
</tr>
</tbody>
</table>

* Variances are averaged over 61 companies which are calculated for each 125 day (half year) period in the post-grant period. Nine periods are represented in total including the first period which is the pre-granting period. The granting window is excluded. Variances ratios are calculated by reference to the pre-grant period (Var/Var(\text{pre-grant period})). The column headed ‘Z’ refers to the standard normal value derived from the Wilcoxon signed-rank test which measures both the direction and size of difference of the ratio of post-grant variance over the pre-grant variance against its hypothesised value of one. The final column attaches the probability of observing the reported value of Z by chance. All variances are standardised by contemporary estimates of the market variance.
in-the-money options whilst out-the-money options might exhibit an increasing variance profile. Our model II predictions are summarised thus:

Test 2: For in-the-money options, the alternative hypothesis of the ex post model is that we observe variances decreasing as a response to managers being increasingly exposed to the downside risk of investment decisions.

Test 3: For out-the-money options, the alternative hypothesis for the ex post model is that we observe variances increasing as a response to a situation in which managers do not participate in option-based remuneration because of their failure to adopt projects which would produce in-the-money options\(^2\).

In a sense, Test 2 is a bad result for the company created by good managers in that the company does not experience greater risk (and hence return) because managers are protecting their unrealised gains. Test 3 has quite the opposite impact in that it produces a good (or intended) result for the company, but brought-about by bad managers. The increase in risk likely to be observed under Test 3 conditions is not likely to be the risk shareholders may wish to be exposed to.

4. Data and sampling

Data has been obtained from the archives of the General Announcements Office of The London Stock Exchange and represents source information. The data archives include records of all changes in the stock options of managers as they are required to be notified under the Stock Exchange Listing Agreement. A key advantage of the data source is that it contains a Stock Exchange stamp of the time of information release to the market, generally to the nearest minute. This enables the event date to be determined accurately.

The initial sample size was 120 companies granting options which, for the time period examined, represents a number close to that of the original population of companies granting options. The type of companies selected varied from listed companies with a market capitalisation as low as £100 million to the major UK listed companies, the intention being to give as wide a picture as possible. However,

\(^2\) Test conditioning: we are aware that by sub-sampling on the basis of moneyness we may be conditioning the tests to (almost) inevitably produce lower risk for high-return in-the-money companies and higher risk for low return out-the-money companies. However, we would argue that this is not an inevitable result for two reasons. First, volatility or risk can be induced without a shift in the mean of stock returns. We accept that a shift in the mean would produce greater variance, but greater variance does not necessarily imply a shift in the mean (this is the mean-preserving spread argument of Diamond and Stiglitz, 1974). Second, we do not in any way define moneyness empirically with reference to the degree or depth of moneyness, only by a simple inequality of stock price at the end year 3 with the stock price at the grant date. Whilst we do not exclude depth from our moneyness definition, it does not necessarily imply that depth in moneyness will arise. As will be seen in the results, the evidence between in- and out-the-money companies would not support a view concerning inevitability.
close examination of the data source revealed a number of potential data problems which we account for. Perhaps the most serious of these was the practice of issuing options up to the maximum permitted under tax legislation, not at one time, but over a period of years in a series of tranches. This creates the problem in examining intertemporal volatility of having overlapping options. Where, for instance, there are a series of options held with varying termination dates the changing incentives to take risks identified above are likely to cancel each other out, to a large extent. To overcome this problem, all companies which had multiple grants were excluded. This left a final sample of 61 companies which had only one grant of options in the period under investigation. By stratifying the population in this way, we increase the focus of our study by concentrating on those companies which have clear incentives arising from options contracts but it remains a comparable sample to previous research (e.g., DeFusco et al., 1990).3

Turning to the sampling period, stock option schemes for employees have been eligible for tax relief since the Finance Act 1980 but executive stock option schemes have only qualified for Inland Revenue approval since the Finance Act 1984. Given the focus on the latter type of scheme, the relevant earliest date for sampling is, therefore, April 1984. Sampling took place up to 1995, thus the sample period covered was 1984–1995.

5. Results and analysis

5.1. Model I

The first test is to examine the pattern of variances over the 4 year period following the granting of options and sub-categorise the analysis by examining variance ratios referenced to the pre-granting period only. Wilcoxon signed rank tests are normally employed to test significance and are used here in testing Tables 1–3. Table 1 details the results for Test 1.

In all of the tables market-adjusted variances are used such that each variance is divided by the variance of the market index. On an average basis, the ratio of the first post-grant variance to the pre-grant variance is above one which ostensibly confirms earlier work in Skinner (1989) and DeFusco et al. (1990). However, the pattern of average variances in subsequent post-grant periods is not consistently increased. Whilst not calculated in the body of Table 1, the ratios of median variances are consistent with that of the average variances by reference to the pre-granting variance. On an average basis, therefore, the granting of options for a wide range of companies would support only the broad contention that volatility was increased as a consequence of the granting of options.

From a more detailed perspective, where both the sign and strength of variance ratios are measured on a company by company basis, a consistent pattern emerges.

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3 Details of the companies studied are available from the authors on request.
Table 2
Variance ratios following the adoption of executive stock option schemes: in-the-money options sub-sample. 1984–1995*

<table>
<thead>
<tr>
<th></th>
<th>Average variance</th>
<th>Ratio of post grant variance to pre-grant variance</th>
<th>Median variance</th>
<th>Maximum variance</th>
<th>Minimum variance</th>
<th>Percentage variances &gt; pre grant variance</th>
<th>Z</th>
<th>One-tailed signed-rank probability for variance change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre grant period</td>
<td>5.345</td>
<td>3.338</td>
<td>53.911</td>
<td>0.612</td>
<td></td>
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</tr>
<tr>
<td>1st post grant period</td>
<td>5.381</td>
<td>1.006</td>
<td>4.042</td>
<td>23.798</td>
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<td>61.7</td>
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</tr>
<tr>
<td>2nd post grant period</td>
<td>5.329</td>
<td>0.996</td>
<td>4.271</td>
<td>22.404</td>
<td>0.976</td>
<td>61.7</td>
<td>2.846</td>
<td>0.0023</td>
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<tr>
<td>3rd post grant period</td>
<td>4.700</td>
<td>0.879</td>
<td>3.879</td>
<td>27.132</td>
<td>0.765</td>
<td>57.4</td>
<td>2.021</td>
<td>0.0212</td>
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<td>4th post grant period</td>
<td>4.186</td>
<td>0.783</td>
<td>3.142</td>
<td>35.739</td>
<td>0.786</td>
<td>44.6</td>
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<tr>
<td>5th post grant period</td>
<td>3.812</td>
<td>0.713</td>
<td>2.560</td>
<td>20.341</td>
<td>0.836</td>
<td>43.4</td>
<td>0.333</td>
<td>0.3707</td>
</tr>
<tr>
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<td>3.991</td>
<td>0.742</td>
<td>2.938</td>
<td>14.724</td>
<td>0.440</td>
<td>54.7</td>
<td>2.223</td>
<td>0.0129</td>
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<tr>
<td>7th post grant period</td>
<td>5.298</td>
<td>0.991</td>
<td>2.463</td>
<td>23.944</td>
<td>0.036</td>
<td>54.5</td>
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<tr>
<td>8th post grant period</td>
<td>4.346</td>
<td>0.813</td>
<td>1.571</td>
<td>35.815</td>
<td>0.866</td>
<td>58.6</td>
<td>1.285</td>
<td>0.1003</td>
</tr>
</tbody>
</table>

* Variances are averaged over 47 companies which are calculated for each 125 day (half year) period in the post-grant period. Nine periods are represented in total including the first period which is the pre-granting period. The granting window is excluded. Variances ratios are calculated by reference to the pre-grant period (Var/Var(pre-grant period)). The column headed ‘Z’ refers to the standard normal value derived from the Wilcoxon signed-rank test which measures both the direction and size of difference of the ratio of post-grant variance over the pre-grant variance against its hypothesised value of one. The final column attaches the probability of observing the reported value of Z by chance. All variances are standardised by contemporary estimates of the market variance.
<table>
<thead>
<tr>
<th></th>
<th>Average variance</th>
<th>Ratio of post grant variance to pre-grant variance</th>
<th>Median</th>
<th>Maximum variance</th>
<th>Minimum variance</th>
<th>Percentage variances &gt; pre grant variance</th>
<th>Observed $T$</th>
<th>Critical $T$ at 95%</th>
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<tr>
<td>Pre grant period</td>
<td>3.939</td>
<td></td>
<td>4.124</td>
<td>7.060</td>
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<td>1st post grant period</td>
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<td></td>
<td>1.790</td>
<td>4.681</td>
<td>26.830</td>
<td>2.647</td>
<td>85.7</td>
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<td>2nd post grant period</td>
<td>6.262</td>
<td></td>
<td>1.589</td>
<td>5.166</td>
<td>15.493</td>
<td>1.512</td>
<td>64.2</td>
<td>15</td>
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<td>3rd post grant period</td>
<td>8.072</td>
<td></td>
<td>2.048</td>
<td>5.010</td>
<td>37.707</td>
<td>1.941</td>
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<td>1.468</td>
<td>5.546</td>
<td>11.408</td>
<td>2.812</td>
<td>78.5</td>
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<td>1.505</td>
<td>4.657</td>
<td>12.538</td>
<td>3.593</td>
<td>100.0</td>
<td>3</td>
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</tbody>
</table>

* Variances are averaged over 14 companies which are calculated for each 125 day (half year) period in the post-grant period. Nine periods are represented in total including the first period which is the pre-granting period. The granting window is excluded. Variances ratios are calculated by reference to the pre-grant period (Var/Var_{pre-grant period}). The column headed ‘Observed $T$’ refers to the Wilcoxon signed-rank test, small sample variate which measures both the direction and size of difference of the ratio of post-grant variance over the pre-grant variance against its hypothesised value of one. The final column reports critical values of $T$ as listed in Table G, Siegal, 1956. A null hypothesis is rejected if Observed $T$ is less than or equal to its critical value. All variances are standardised by contemporary estimates of the market variance.
of increased variance over the full time horizon sampled. For example, in all cases the number of companies experiencing a variance increase is at no point below 50% of the sample, with the highest proportion reflected in the first post-grant period. This result is reflected in the large-sample, Wilcoxon-based Z-statistic which suggests that, with the exception of post grant periods 4 and 5, firms in the sample experienced variance increases at a statistically significant level. For variances referenced to the pre-grant period, therefore, we could not accept the null hypothesis implied in test 1 that the granting of options has no effect on the long-term pattern of volatility. Such a result confirms and extends the general findings of earlier US-based work based on shorter and cumulative sampling horizons. Broadly, therefore, we cannot find any evidence which might suggest that a longer-horizon view, based on a broad sample, offers a perspective on managerial behaviour which is different to that found at shorter sampling horizons. In essence, option-based contracts appear to incentivise managers to increase the risk profile of their organisations.

5.2. Model II

The results for tests 2 and 3 are reported in Tables 2 and 3, respectively, and represent sub-samples of the data reported in Table 1. The separation of the data is based on dividing the sample into in- and out-the-money options defined on the basis of the pattern of stock prices compared to exercise prices (the prices ruling at the grant date). For example, if a company’s stock price at the end of year 3 (the earliest date which exercise is allowed) is less than the stock price at the time of granting then the option is defined to be out-the-money. In-the-money options are analogously defined. This approach identifies a decision-point in the life of the option contract such that managers are now able to exercise their options and, hence, moneyness becomes tangible. Table 2 provides the details for in-the-money options and comprised a sample of 47 companies.

On the basis of the ratio of post-grant in-the-money average variances to the pre-grant period we observe an initial increase followed by ratios which universally suggest a decline in variance. For the most part, there is a higher proportion of companies that experience an increase in variance as opposed to a decrease but, it appears, the size of the increase (as opposed to its direction) is marginal compared to the overall sample represented in Table 1. This observation is supported by the Z-statistics which present an equivocal pattern of the evolution of variances and suggests that the continued existence of option contracts does not consistently incentivise managers to undertake risky projects over a time horizon that matches more closely that of the option contract. Indeed, notwithstanding that the options are in issue, there appears, in terms of the explanation offered by the existing literature, a perverse result that options increase the risk aversion of managers. This result is, however, consistent with the ex post model outlined above. Against a background of generally rising prices, therefore, our conclusion is that in-the-money options do not support an incentive to take a risk-enhancing, project-choice strategy when benchmarked against return variance in the immediate pre-granting
period. If the pre-grant variance is in any way accepted as a normal measure of volatility (which it may well be if it represents the period when the decision is made to grant options) then options do not induce managers to take riskier decisions when it is likely that they will participate fully in the distribution of returns, including the downside.

Table 3 provides the comparator analysis for out-the-money options with a sub-sample size of 14. The relatively small sample against in-the-money variances is to be expected in a generally inflationary environment, which was the experience in the sample period. Table 3 reports evidence of average variance increases over the sample horizon and the analysis is confirmed when variances are calculated on a median basis. The detail, on a company by company basis, reinforces the summary results in that the proportion of companies experiencing variance increases is universally above 50%. For all but one of the post-grant periods in Table 3 the small sample Wilcoxon test statistics are significant at 95%4. It appears, therefore, that variance increasing activities are substantial which provides support to an incentive structure that managers are choosing projects on the basis that, with respect to option values at least, they have little to lose personally5. In this situation it is quite possible that another perverse result emerges. Given the background of rising stock prices generally, the 14 companies comprising the sample in Table 3 have done particularly badly: so much so, that managers have overcome systematic increases in corporate value so as to reduce the value of their own organisations. On these grounds, it may be reasonable to argue that Table 3 measures variances which could be attributable to the managers (and in a conservative manner given the off-setting effects of systematic variance reductions), who have already demonstrated their inability to improve the fortunes of their companies. To then induce such managers to take riskier investment decisions does not seem, on the face of it, an act which is likely to maximise shareholder wealth.

One further observation is also relevant. Assuming the sub-samples to be truly disjoint in the sense that the sample partitioning properly reflects the characteristics of in- from out-the-money options, then it is true to say that the total sample variance analysis represented in Table 1 is inflated by the incorporation of variances of companies who exhibit out-the-money characteristics. The analysis of volatility response to option granting should therefore be conducted, we would argue, on the grounds of stratified samples based on options being in- or out-the-money, as expressed in Tables 2 and 3. By doing this, we suggest that the analysis more accurately reflects the incentive structures managers face in holding options from which clearer intertemporal effects may be discerned. A more consistent explana-

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4 The observed test statistic, $T_0$, has to be less than its critical counterpart for the null to be rejected. See Table G, Siegal, 1956.

5 In such a situation, managers face only potential losses to human capital, $W_h$, since the value of option holdings in $W_s$ is at its minimum value of zero. It could be argued that any response by management to the continued existence of option contracts at their minimum value can therefore only lead to activities which increase variance.
tion for existing findings might then be related to a misinterpretation of immediate post grant variance increases and a failure to recognise the role of options being in- or out-the-money. With respect to the first point, it may be argued that the initial increase in variance is not necessarily a function of the incentivisation of managers. Rather, it seems more plausible that the granting of ESOS may produce uncertainty amongst investors as to the potential response of managers to the creation of a highly volatile reward system. This would be a market phenomenon and is independent of actual managerial investment and financing decisions. Moreover, it might be unrealistic to expect variance-inducing projects to be reflected in corporate volatility so soon after the granting of options. The significance of this point rests with a recognition of measuring the impact of options on managerial behaviour over an appropriate time horizon. The (usual) cumulative approach is to measure the impact of granting over different lengths of time but with the same starting point. Thus, a typical approach would involve the measurement of variance from some time shortly after the granting in projections of increasing length from the same starting point (as in DeFusco et al., 1990; Gucseli and Ho, 1993). However, this cumulative approach to analysing volatility fails to separate any initial market response to the issuing of an ESOS from longer term changes in managerial investment and financing decisions over the life of the option contract. This method, furthermore, does not tackle the apparent contradiction of why variances are not significantly increased when options are still yet to be exercised in periods more relevant to the life of an option (3–10 years)\textsuperscript{6}. Thus, the existing approaches, by limiting their time horizons and the way in which variances are referenced, run the risk of confusing an initial response of the market to the issue of options which induce managers to engage in making riskier (volatility-inducing) investment decisions.

In sum, proponents of the argument that the granting of options has a volatility-inducing impact on managerial behaviour universally cannot sustain such a view over the longer-term when presented with the evidence of Table 2. We offer the market-based view as a possible explanation for our different results, although we do suggest that undiscriminating analysis of this kind, which does not reflect the ‘moneyness’ in stock options, may be subject to the very large variances of companies run by managers holding out-the-money options. For this reason, we suggest, the sampling time horizon is therefore a relevant perspective.

6. Leverage effects

One possible source of change in volatility over time may be due to alterations in financial risk arising from changes in gearing and, as such, may be independent of managerial influences. If firms are levered, then, even if the manager does not actively influence asset variance or firm leverage, growth in asset value will cause

\textsuperscript{6} The average time a stock option is held in the UK is 6.6 years, see Income Data Services (1998).
leverage to decline (and vice versa for a decline in asset value). This will cause the volatility of equity returns to decline in the same way that a call option’s volatility declines as its asset value increases. Consequently, firms with options that, for example, end-up out-the-money will tend to have higher growth in stock return volatility than firms with options that end-up in-the-money. Thus, it may be the case that we simply observe volatility changes which are due to leverage effects and hence, not necessarily, attributable to the existence of stock options.

In order to examine the potential impact of changes in leverage, we report in Table 4 average gearing over the grant and post grant periods for the samples conditioned on option moneyness. Gearing data is extracted from Datastream and is defined as the ratio of the debt to capital employed. For in-the-money companies we would expect a fall in the gearing ratio as asset values increase. For out-the-money companies we would expect a decrease in gearing.

The table reveals, for in-the-money options that, on average, gearing has increased by about 7% over the sample period. There were no outliers in the sample. Under such circumstances we would expect an increase in the financial risk of the companies with a corresponding increase in variance of returns. In fact, what we do observe is that those periods with the most marked increases in variance (periods 1, 2, 3 and 6) are not closely matched by periods when large changes in gearing were apparent (periods 1, 4, 5, 6, 7, and 8). Whilst there may exist complex lag structures in the response of financial risk to gearing changes, such effects do not appear discernible from the evidence presented. Nevertheless, the general images of reduced risk and increased gearing reinforce our results and make our conclusions more conservative. For out-the-money options, we observe a decline in gearing over six out of the eight post grant periods. On its own, this might suggest a reduction in financial risk. If that is the case then the increases in operating risk indicated in Table 3 was more than that reported if the general background of financial risk was in decline. As with in-the-money options, the assessment of our results is made more conservative because of the impact of gearing.

7 The inverse relationship between stock prices and volatility has been well-documented in the past (Black, 1976).

7. Conclusions

We have proposed models of managerial response to incentive structures put in place by the granting of stock options and tested these against a representative sample refined on the basis of the pattern of multiple granting of options. Our analysis thus examines the incentives that may be put in place by the granting of options which may lead managers to focus on the impact of their investment and financing decisions on stock price volatility.

Our results, without segregation of the sample, support the conclusion that there are significant variance changes immediately following stock option granting, when referenced against the pre-granting variance benchmark. For the full sample,
Table 4
Leverage analysis following the adoption of executive stock option schemes: 1984–1995

<table>
<thead>
<tr>
<th></th>
<th>Gearing ratios for in-the-money companies</th>
<th>Ratio of grant date gearing to post grant gearing for in-the-money companies</th>
<th>Gearing ratios for out-the-money companies</th>
<th>Ratio of grant date gearing to post grant gearing for out-the-money companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grant date</td>
<td>0.624</td>
<td>0.372</td>
<td></td>
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<tr>
<td>1st post grant period</td>
<td>0.634</td>
<td>1.016</td>
<td>0.319</td>
<td>0.857</td>
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<tr>
<td>2nd post grant period</td>
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<td>0.971</td>
<td>0.359</td>
<td>0.965</td>
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<td>3rd post grant period</td>
<td>0.574</td>
<td>0.919</td>
<td>0.382</td>
<td>1.027</td>
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<td>4th post grant period</td>
<td>0.657</td>
<td>1.052</td>
<td>0.345</td>
<td>0.927</td>
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<td>5th post grant period</td>
<td>0.726</td>
<td>1.163</td>
<td>0.356</td>
<td>0.956</td>
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<td>6th post grant period</td>
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<td>1.072</td>
<td>0.326</td>
<td>0.876</td>
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<td>7th post grant period</td>
<td>0.720</td>
<td>1.153</td>
<td>0.331</td>
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<td>8th post grant period</td>
<td>0.687</td>
<td>1.101</td>
<td>0.402</td>
<td>1.081</td>
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* Gearing ratios are provided for both in-the-money and out-the-money samples. Nine periods are represented in total which include gearing at the date of granting and for each half-year period thereafter. The sampling period matches those of tables 2 and 3. Gearing is defined as the ratio of total loan and preference capital to total capital employed less intangibles (Datastream, 1991).
variance increases were found when assessed by the Wilcoxon signed-rank test. The methodology involved examining a series of discrete intervals post granting, rather than the approach in the existing literature of investigating cumulative periods. Notwithstanding this, the results support earlier, US-based work which suggests that variance increases following the granting of options. Our perspective does not suggest that taking a longer time-horizon, more consistent with the time to maturity of the option, contradicts such work.

The second stage of our study departs from the approach in the existing literature in analysing a division of the sample with respect to whether options are in- or out-the-money. The purpose of distinguishing on these grounds is to give a perspective on managerial response in a realistic environment in which managers are able to respond dynamically in making risky investment and financing decisions. Our tests have also included an analysis of firm leverage to discount any potential contamination of our results due to changes in financial risk alone. The incentive structure for in-the-money options might possibly suggest a risk reduction strategy as managers seek to protect the accumulated gains that have arisen over time. Our results suggest that there is a small increased variance in the initial post granting period, but subsequent intervals indicate a mixed response, at best. The initial variance increase is explained as a market phenomenon, rather than the result of increased risk-taking by managers as suggested in the current literature. The subsequent reduction in stock price variance observed in Table 2 contradicts the existing literature, but is consistent with the behavioural model developed in this paper which argues that managers with deep in-the-money options will, given the volatility of ESOS values, become not less risk averse, but more risk averse. This result also explains the problem in some existing work of why increased volatility has been found initially, relative to the pre grant period, but diminishes thereafter, notwithstanding the fact that the option contracts are still in issue.

In analysing out-the-money options we find effects consistent with the implications of our earlier analysis in that managers may be incentivised to take risk-increasing project decisions because they do not have any option-based wealth to personally risk. This is in sharp contrast to the position of the company, and hence two potentially perverse results may arise. Firstly, it is possible that, even though the company has faced declining fortunes with executives holding out-the-money options, the continued existence of ESOS induces managers to increase the risk profile of their investment decisions even further despite the fact that the company has already experienced a significant degree of risk increase. There is potentially no limit to this if the fortunes of the company continue to decline. Second, it is poor managers who are incentivised to take riskier decisions since their investment judgement is possibly already questionable given the combined evidence of declining stock price against a backdrop of a generally rising market. In sum, the continued existence of option contracts, in declining companies, forces a wedge between corporate and personal incentives in a way that cannot have been the objective in granting options in the first instance.
Acknowledgements

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References

Ormrod, P., Brookfield, D., 1996. Director share option schemes and market signalling, Liverpool University, 1–26, working paper.