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# DO EXECUTIVE STOCK OPTIONS ENCOURAGE RISK-TAKING?

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## Abstract

Executive stock options create incentives for executives to manage firms in ways that maximize firm market value. Since options increase in value with the volatility of the underlying stock, executive stock options provide managers with incentives to take actions that increase firm risk. We find that executives respond to these incentives. There is a statistically significant relationship between increases in option holdings by executives and subsequent increases in firm risk. This relationship is robust to the inclusion of fixed effects, year effects, and a variety of other controls and does not seem to be driven by reverse causality. However, the estimated effect on risk-taking is small and we do not find a negative (or positive) market response to option-induced risk-taking. In sum, although options appear to increase firm risk, there is no evidence that this effect is either large or damaging to shareholders.



Keywords: executive compensation, executive stock options, volatility, leverage.

JEL classification codes: G31, G34

During the past 20 years, executive stock options have grown from a trivial piece of executive pay to the largest single component. Indeed, for many top executives, the value of annual stock option grants swamp annual cash pay by a significant margin. The driving force behind this change has been the growing desire to link the fortunes of managers and owners to mitigate the agency problem (Jensen and Meckling, 1976).

Coinciding with the option explosion, a large academic literature has emerged (See Murphy, 1999, for a summary) that examines the way in which executive compensation, and stock options in particular, has affected the agency relationship. The evidence suggests that the low pay-to-performance relationship estimated by Jensen and Murphy (1991) has been dramatically strengthened by the stock option explosion since executives now generally have very large holdings of company stock and stock options in their portfolios (Hall and Liebman, 1998). Moreover, the resulting pay-to-performance relationship seems to be in accord with the most basic predictions of agency theory (Aggarwal and Samwick, 1999). In short, it seems pretty clear that the stock option explosion has increased the alignment between managerial and shareholder interests, thereby reducing the agency conflict, though not everyone appears to agree with this conclusion. (See Yermack, 1995, for one example).

But in terms of providing incentives, options are not stock. And there is concern that options may provide harmful incentives in addition to the generally beneficial incentives provided by larger overall managerial equity stakes. In particular, unlike stock, options have an asymmetric payoff and, unlike stock, options do not normally pay dividends. Since the value of options increase with

firm volatility and decreased with dividends, options are purported to give executives incentives to increase risk-taking[1] and to decrease dividends.

The latter appears to have happened. Old economy companies have decreased dividends, or at least decreased the rate of growth of dividends, while new economy companies rarely pay dividends. This has caused overall dividend rates to fall (Fama and French, 1999). Moreover, the evidence suggests that there is indeed a connection between the stock option explosion and lower dividend rates. For example, Jolls (1998) finds that companies with option-rich executives appear to be substituting stock repurchases for dividends, which is exactly in line with the incentives provided by options.

Despite the importance of the topic, however, there appears to be essentially no evidence on the link between option grants and firm riskiness. Guay (1997) finds, in 1988 data (which largely predates the option explosion) that firms appear to grant options more frequently in companies with growth opportunities, which is consistent with the explanation that firms may attempt to use options to increase risk-taking. Likewise, Tufano (1998) finds evidence in gold mines that managers with more options hedge gold price risk less. Using data from 1978 through 1982, DeFusco et al. (1990) find a positive stock market reaction and a negative bond market reaction to the announcement of a stock option plan. But the most basic question of whether option grants, and the option explosion, have led executives to increase firm riskiness has not been addressed directly.

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[1] Lambert, Larcker and Verrecchia (1991) show that options may, for certain parameter values, decrease incentives for risk-taking. Although the expected value of option payoffs rise with volatility of the underlying asset, options are risky assets and risk-averse (and undiversified) executives may become more risk-averse if loaded up with options.

Moreover, even if it were established that options increased risk taking, it is not clear whether such an outcome would be desirable or undesirable from the perspective of the shareholders. Risk-averse managers, who hold disproportionate amounts of their financial and human capital in the companies they manage, are likely to take fewer risks than are optimal. This is an agency problem that is likely magnified in companies where top executives enjoy substantial rents from their positions, and have strong incentives not to take risky actions that may get them removed from their positions. Thus, not only do we not know whether stock options encourage risk-taking, we also do not know whether such an outcome would be damaging or harmful to shareholders.

These are the questions addressed in this paper. Using a rich data set that enables us to measure both the amount and the precise characteristics of executive stock option holdings, we examine the connection between the risk-taking incentives of stock options and various measures of firm risk. We find that controlling for other effects, CEOs with option holdings that are large relative to their wealth and whose value is sensitive to stock-price volatility tend to increase the volatility of the firms they control. One method for increasing stock volatility which managers employ is to increase firm leverage: We find a positive and significant relation between the wealth elasticity with respect to volatility and leverage. Our tests employ careful controls, including controls for CEO and firm characteristics as well as firm and year fixed effects. The evidence from our tests suggests that option grants lead to greater stock price volatility rather than the reverse.

Our findings also suggest that the economic importance of options' incentive effects is small. The size and accuracy of our data set enable sufficiently precise measurement to find compelling statistical evidence that there is an effect. However, the size of the effect is such that ordinary option grants have only small impacts on firm risk. Moreover, our tests of stock-price response to option-induced risk-taking find no evidence of costs or benefits to shareholders from this activity. The excess returns associated with the interaction of CEO option sensitivity and increased stock volatility is economically small and statistically insignificant.

This paper proceeds as follows: Section I briefly reviews the incentives created by stock options. Section II describes the data used in our empirical tests. Section III explains the methodology of our tests, and describes our findings. Section IV concludes.

## I. Managerial Incentives Created by Executive Options

The value of an option depends on six inputs: The riskless rate of interest (r), the price of the underlying security (S), the exercise price of the option (X), the time remaining until the option expires (T-t), the rate of dividend payment of the underlying (d) and the volatility of the underlying ($\sigma$). r is determined by global markets and is thus beyond the influence of any single corporate executive. X and T-t are features of the option that are easily observed by shareholders and thus cannot be unilaterally affected by corporate managers.[2] S represents the price of the underlying stock. Since executive stock options are call options, their value is increasing in S and so the possession of options creates an (additional) incentive for the manager to take actions to increase the company's stock price. This is presumably the primary reason shareholders approve option grants.

However, managers also have some control over the two other main determinants of option value, the firm's dividend rate and the volatility of equity. First, managers very often decide the firm's dividend rate. Since call option values are decreasing in the dividend level (dividend payments lower the stock price), and the exercise prices of executive stock options are rarely adjusted for dividends, the manager's incentive is to reduce dividends as much as possible. Jolls

[2] Option "repricings," which change the exercise price of previously-granted options, do occur. However, they are quite rare. Hall (2000) found that less than 2% of eligible options were repriced in 1998, a level of repricing consistent with the amount found by Chance, Kumar and Todd (1997).

(1998) shows that managers who receive option grants have a greater tendency to replace dividends with share repurchases. Jolls' findings are interesting, because they suggest that managers may be willing to adjust the firm's financial policy to increase their own compensation. However, as there is little theoretical or empirical reason to think dividend policy has large effects on firm value, dividend changes may not be of great concern to shareholders.

Second, managers can affect the volatility of firm's equity. Risk-averse managers who are compensated in traditional ways (salary, bonus and stock) have incentive to keep the volatility of the firm low when they hold a large fraction of their human capital and their financial wealth in the firm. Such managers have incentives to turn down risk-increasing, positive NPV projects if the negative effect on their expected utility of an increase in total firm risk is larger than the positive effect of an increase in firm value. Highly undiversified, risk-averse managers will require increases in firm value to compensate them for increases in systematic risk that will be larger than those required by well-diversified investors with similar risk aversion. Moreover, these managers will also care about increases in idiosyncratic risk and will strive to avoid even idiosyncratic risk as well as systematic risk. As a consequence shareholder value will not be maximized.

Executive stock options present a potential cure for this problem. The asymmetric payoff of an option induces the holder to prefer high volatility of the underlying security; as is well known, the value of any option (and, in particular, the value of a call option) is monotonically increasing in $\sigma$. However, whether this potential benefit actually occurs has never been thoroughly tested.[3]

Of course, options may create incentives that are not so salubrious. If the effects of risk-taking an option value are sufficiently high, reasonably risk-tolerant executives may engage in too

[3] Esty (1997) shows evidence of increased risk-taking by managers of S&Ls with negative net worth; their stock holdings can be viewed as an out-of-the-money option.

much risk taking. They may actually pursue projects they know have negative NPV if the projects are sufficiently risky.

Options are not usually granted over the total value of the firm, but over the value of the firm's equity (i.e., the stock price). There are two ways to increase stock price volatility, and hence stock options value. The first is to take on riskier projects (i.e., to increase risk on the left-hand side of the firm's balance sheet at market values). The second is to increase leverage of the firm (i.e., to increase risk on the right-hand side of the balance sheet). If firms are at an optimal capital structure, deviations from that optimum are not value-creating and may be in fact value-destroying (if the relation between leverage and value is not flat). Again, depending on the specifics of this tradeoff and of managers' utility functions, executive stock options could cause value destruction by motivating managers to overlever the firm.

## II. Data

The basic data for this paper come from the merger of several databases. The most important is the Hall-Liebman (1998) database of CEO stock option holdings, which contains precise information on compensation, including characteristics of stock options for each CEO as well as stock holdings, salary and bonus. Salary and bonus are obtained from proxy statements. The procedure by which stock option values are computed is described in detail below and in the Appendix.

The Hall-Liebman data covers 478 firms that were randomly selected from the largest 792 firms in 1984 to avoid selection bias. The holdings of the CEOs of these firms were tracked from 1980 through 1994. Compensation data and data on CEO characteristics such as age and tenure were hand-collected (by Hall and Leibman and by Yermack) from firm 10-Ks and proxies. To these were added return, size, market beta, and volatility data that were obtained or computed from CRSP, and firm leverage computed from COMPUSTAT data. Returns are annual returns including dividends. Volatility is the standard deviation of daily returns over the last six months of the fiscal

year, and then annualized. Betas are taken from the CRSP Annual Stock File. Leverage is measured as (long-term debt plus interest-bearing short-term debt)/(market value of equity). [4]

The advantage of the Hall-Liebman data set for our purposes is that, since we are concerned with the connection between executive risk taking and risk-taking incentives, it is necessary for us to have a very good estimate of the precise portfolio of executive stock option holdings, including details about the number, exercise price and maturities of all options held. This precludes the use of the widely used Standard & Poor's ExecuComp data set, which has none of these details and does not include option holdings when the options are underwater, making it impossible to get a true sense of the options holdings of many executives.

We value stock options based on the Black-Scholes (1973) formula for valuing European call options, as modified by Merton (1973).[5] To construct a measure of the total stock option holdings of each CEO at a given point in time, we use proxy data on stock option grants, gains from exercising stock options, and the total number of stock options held by the CEO. Annual proxies contain information on options granted during the preceding fiscal year, including the number, duration, and exercise price of the options. In order to construct a CEO's total holdings of stock options, we go back to the first year in which the CEO held that position and use the annual data on option grants to build up the stock of stock options held by the CEO, including the exercise price and remaining duration of each option.[6] Each year, we reduce the remaining duration of options granted in the previous year, add the options granted in that year, and subtract options sold.

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[4] The results reported in this paper are robust to changes in the definition of leverage, such as using equity plus debt in the denominator.

[5] Refer to Hall and Liebman (1998) for details.

[6] In constructing the stock of stock options for 1980, the first year in our data set, we go back only to 1971. Since most stock options have a duration of 10 years, and since only 32 CEOs in our sample both were CEOs in 1970 and held stock options in 1971, we are losing little information by not going back further. Moreover, in those few cases,

There are three characteristics of the data that complicate this procedure. First, CEOs often hold options that they received before they became CEO. Second, the exercise price is sometimes missing. Third, the proxies report option gains as a dollar value, so it is impossible to determine exactly which options were sold in a given year. We are helped, however, by the fact that proxies sometimes contain information on the total number of options held by the CEO (or alternatively the total number of vested options held by the CEO). This information on total options allows us to test the accuracy of our algorithm for building up the stock of stock options holdings and to adjust for cases in which our algorithm produces an inaccurate count of stock options. Details concerning the methods used for handling these difficulties are described in Hall & Leibman (1998).

## III. The Effect of CEO Compensation on Firm Risk

This section explores the effect of CEO compensation on firm risk. We have noted in Section I that the effect of an increase in firm risk on CEO's wealth depends on how much of this wealth comes from stock options relative to other forms of compensation such as salary and stock holdings. For a CEO who cares about percentage changes in wealth rather than absolute changes in wealth, we can measure this effect through the total CEO wealth elasticity with respect to stock volatility. This variable captures the effect of volatility changes on the total wealth of the CEO, and not only on the value of her option package. Wealth elasticity is defined as follows

$$\text{Wealth elasticity} = \partial \log(\text{wealth}) / \partial \log(\sigma)$$

where we proxy for wealth using total stock plus option holdings in the firm.

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we use our regular procedure for handling initial conditions (see below) in order to calculate the number of stock options held at the end of 1970.

Total wealth elasticity depends on the value of the options granted to the CEO, their exercise price, the volatility of the stock, and all the other variables that affect option prices. Because we do not observe CEO total wealth, we use her holdings of stock and options in the firm as a proxy. Also, to avoid mechanical relations between stock volatility and total wealth elasticity in the regressions, we set volatility to the median value for all firms when computing wealth elasticities, but we allow all the other variables to take firm-year specific values.

Figure 1 plots a time series of the median CEO wealth elasticity with respect to stock volatility in our sample. This elasticity was about zero in 1980, but it has increased steadily since then. Figures 2 and 3 are helpful to understand this historical pattern of CEO's wealth sensitivity with respect to volatility. Figure 2 plots a time series of the mean fraction of CEO wealth in stock options. While stock options represented about 28% of CEO wealth in 1980, this proportion had doubled by 1994. Figure 3 shows the effect of volatility on CEO wealth elasticity.[7] This figure shows that this relation has two important properties. First, for the parameter values considered here, elasticity is always nonnegative for all values of volatility. Second, the relation between volatility and elasticity is non-monotonic. However, for plausible values of stock return volatility (volatility less than 60% per year), the relation is positive.

Table 1 reports some descriptive statistics of the data for the full sample and the year 1994. Not surprisingly, average and median options holdings in 1994 are much larger than in the full sample. Wealth elasticity is correspondingly larger. By contrast, stock return volatility is about the same. Tables 2 through 8 report the empirical results of the paper. Throughout the paper we report regression results from panel data with firm and year fixed effects and two estimation methods,

[7] Wealth elasticity with respect to volatility also depends on the moneyness of the option as well as all other variables that determine the value of an option. In this plot we set the ratio of the stock price to the exercise price equal to the time average of the median value in our sample (about 1.2), a dividend rate of 3%, duration of 10 years, and risk free rate of 6%.

robust least squares and median regressions. We discuss in Section III.A below the statistical advantages of including fixed effects in the panel regression, as well as of using median regressions. All standard errors are robust to heteroskedasticity. The main dependent variable is the total CEO wealth elasticity with respect to volatility. However, to avoid identifying spurious regression results, we also consider a set of control variables that include the log of the market capitalization value of the firm, the log of the value of the CEO options plus the value of her stock holdings, the log of the CEO salary plus bonuses, the tenure of the CEO, and her age.

The dependent variables are stock return volatility, leverage and stock return. It is important to stress that the explanatory variables are always measured with at the end of firm fiscal year (t-1), while the dependent variable is measured in firm fiscal year t. Specifically, volatility is measured over the last 6 months of the firm fiscal year t, leverage is measured at the end of fiscal year t, and returns are measured over the last 6 months of the firm fiscal year t. Our basic regression equation takes the form:

$$\sigma_{it} = \alpha + \beta((\text{Wealth elasticity})_{i,t-1}) + \gamma_1 \log(\text{option}_{t-1} + \text{stock value}_{t-1}) + \gamma_2 \log(\text{salary}_{t-1} + \text{bonus}_{t-1}) + \gamma_3 \log(\text{firm market value}_{t-1}) + \gamma_4(\text{Tenure}_{t-1}) + \gamma_5(\text{Age}_{t-1}) + \delta_i + \mu_t + \varepsilon_{it}$$

## A. Wealth elasticity and volatility

Table 2 documents the empirical relation between total firm stock return volatility and our measure of CEO wealth elasticity. This table reports the results of a regression of volatility measured over the last 180 days of fiscal year t on wealth elasticity at the beginning of fiscal year and a set of control variables. It shows the primary finding of the paper: a positive and significant relation between CEO wealth elasticity and subsequent firm volatility. In discussing the findings, we will focus on the median regression results, which minimize the effects of outliers; in general the least-squares results are quite similar, and we will highlight cases where they are not. The coefficient is .087, with a t-statistic of 8.54. In addition to its strong statistical significance, this result is also economically significant. Given the trend in the median CEO wealth elasticity shown in Figure 1, the typical elasticity for a CEO today is likely to be around .36 (this would have been a

high level back in 1994; at that time it represented the 95$^{th}$ percentile). This regressions suggests that taking a CEO with no option holdings (wealth elasticity with respect to volatility of zero) and raising him to an elasticity of .36 will lead to a change in firm volatility of .087×.36, or .031. Since the median firm in our sample has a volatility of .3, this represents a 10% increase in firm volatility, which is considerable.

In general, there are no great surprises in the coefficients on the control variables. The strongest finding is the powerful negative relation between firm size and firm volatility, a result which is well known. Additionally, we find a strong positive relation between the value of CEO stock and option holdings and firm volatility. This result is somewhat surprising, in that we might expect that the risk aversion of executives would cause those with greater firm holdings to reduce firm volatility. This result, however, disappears when we control for firm and year fixed effects (see discussion below). Cash compensation (salary plus bonus) also exhibits a positive relation with volatility; this is more in line with our theory as managers with greater cash compensation are risking less by making the firm more volatile. Finally, CEO age is negatively related to volatility, while CEO tenure shows no significant relationship.

In the second panel of the table we show the results of a fixed effects regression. Here in addition to the other controls we include fixed effects for each firm and for each year. In this way we minimize any effects of endogeneity: The fixed effects are likely to pick up any covariation that is caused by particular firms or time periods having unusual characteristics. For example, in the early years of our sample executives held many fewer options as a group. If the earlier years of return data exhibit especially high or low return volatility, this could contaminate the regression results. The fixed effects minimize this sort of concern. The firm and year dummies also mitigate any concerns about serial correlation or cross-correlation of the errors, making our standard errors easier to interpret. Finally, the dummies have the implicit effect of differencing the data. By comparing each firm to itself, only changes by a firm in the CEO's wealth elasticity or in return volatility affect the regression; any stationary firm policies will show up in the fixed effects. This makes an interpretation of causality more plausible.

Including these fixed effects makes for an extremely stringent test of the null hypothesis; i.e., it makes the null hard to reject. And indeed, some of the results for our control variables are no longer significant – in particular CEO age and cash compensation.

The inclusion of fixed effects does not change our basic finding, though it does reduce the magnitude of the coefficient considerably. Now wealth elasticity predicts volatility with a coefficient of .030 (t-statistic of 4.39). The statistical significance is still strong; the size and precision of our data set enables us to obtain relatively small standard errors. A key issue is the interpretation of the economic significance of the coefficient. There is certainly a plausible argument to be made that the economic impact is small. Multiplying typical CEO wealth elasticities for 1995 by the .03 coefficient gives results in the range .005-.01. So even going from no option to a normal number has a relatively small effect on firm volatility, raising it by perhaps 1-3%. A typical option grant, then, has a tiny effect as one year's grant is normally a small fraction of an executive's total holdings (and thus of his total elasticity). By this standard, our evidence can be read as saying that the incentive effects of executive stock options are overstated and that too much attention is paid to them.

However, an alternative interpretation might suggest that the size of the effect is far from trivial. Consider a large, risky project – let us choose as an example the Saturn project undertaken by General Motors some time ago. How much does such a project change the volatility of a firm's returns? The answer depends on many factors, such as the market's view of to what extent the success of the project is a signal of the firm's future growth prospects. But it is not likely we would expect such a project to change GM's annual volatility from 30% to 50%. Surely a change to 32% or 35% would be more plausible. So the kinds of volatility changes we are observing as consequences of (large) changes in option holdings may in fact be caused by quite substantially different manager behavior. In addition, we should not overlook the possibility that the movements we observe are caused by a small number of truly titanic business shifts encouraged by option holdings (say, Encyclopaedia Britannica choosing to put a large fraction of it's resources and corporate health into a bet on britannica.com), together with a larger number of firms where the option grants have little or no effect on manager behavior.

## B. Robustness tests

Table 3 shows results when the most recent year's option grant is not included in the elasticity calculation. This further reduces the possibility of endogeneity by measuring volatility over the period (t+1/2) to t while using only option grants up to time (t-1) to compute sensitivity to volatility. This causes the regressand to be measured almost two years after the regressor's value is determined. The results are completely consistent with those in Table 2. Without this test, it would seem reasonable that perhaps options are granted in anticipation of a change to a more volatile business. Such an argument, however, would stand in direct contrast to the findings in Aggarwal and Samwick (1999). Table 3 makes such a theory highly implausible, as it would take an extremely forward-looking board to anticipate changes years ahead and implement appropriate new compensation schemes immediately.

Table 4 shows the regression results when lagged volatility is included in the regression as an additional control. It is possible that the regression results in Table 1 are just capturing some mean-reversion effect in volatility. Though we do not use the firm's current volatility to compute the CEO wealth elasticity precisely to avoid mechanical relations between stock volatility and elasticity, this elasticity might be still correlated with current volatility through the other variables that enter its computation (such as the current stock price). In that case, it could be argued that the statistically significant relation we observe between wealth elasticity and subsequent volatility is just a proxy for expected changes in volatility. One possible way to control for the effect of persistence in volatility is by including lagged volatility in the regression. Table 3 shows that the estimated coefficient on wealth elasticity is significant and about the same magnitude after we control for lagged volatility. The coefficient on lagged volatility is positive and highly significant.

## C. Systematic vs. idiosyncratic risk

Tables 5 and 6 decompose firm stock return volatility into systematic (Table 5) and idiosyncratic (Table 6) volatility. The goal is to determine whether executives are adding to the

systematic risk of the firm (which can lower firm value if expected cash flows are unchanged) or if the effects are idiosyncratic (in which case firm value is changed only if expected cash flows increase or decrease). We decompose firm returns each day using the standard CAPM model:

$$R_i = R_f + \beta_i (R_m - R_f) + e_i$$

where $R_i$ = total return on stock i, $R_f$ is the Treasury bill rate, $\beta_i$ is the market model beta described in Section II, and $R_m$ is the market return. We measure systematic risk as the standard deciation of $\beta_i (R_m - R_f)$ and idiosyncratic risk as the standard deviation of $R_i - \beta_i (R_m - R_f)$.

The findings for idiosyncratic risk are almost identical to those for total risk. The coefficient on wealth elasticity is .032, with a t-statistic of 3.35 (in fixed effects regressions). The evidence on systematic risk is less clear. The coefficient in the fixed effect median regressions is insignificant and negative, and for the LS regressions the t-statistic is –2.41. On the other hand, the non-fixed effects regressions show positive coefficients. Overall, there is little evidence of any effect. However, market beta estimates are notorious for their large estimation error, and it is certainly possible that our estimates of systematic risk are simply too imprecise to capture any effect. In the next section we present a potentially superior measure of systematic risk.

### D. Wealth elasticity and leverage

The quickest and easiest way to increase the volatility of a firm's equity is not to take on risky projects. Rather, it is to make the equity riskier without changing assets by levering up the firm. If managers act on the incentives we have discussed, a leverage increase would be one of their choices. Table 7 reports on tests akin to those in Table 1, but using firm leverage as the regressand rather than firm volatility. The findings are consistent with the theoretical predictions. The coefficient of wealth elasticity on the log of leverage is .163, with a t-statistic of 3.32. Again, applying our standard increase from zero elasticity to .36, we see that such an option grant would on average generate a change in log leverage of about .06. Since the median firm in the sample has log leverage equal to -.30 (approximately 75% leverage), this represents a substantial leverage change. Of course, as above the change induced by an ordinary option grant will be much smaller.

This result is a direct test of an implication of the results in Jolls (1998). Jolls has investigated the possibility that managers use techniques other than improving firm profitability to influence stock price. In particular, she finds that executives with larger option holdings are more likely to replace dividends with share repurchases. A share repurchase program is a form of increasing leverage.

### E. Returns from increases in risk

The main goal of stock options as a corporate governance instrument is to give executives an incentive to increase the value of the firm. We have shown some empirical evidence that there is a positive relation between executive stock option awards and firm risk. However, it would be interesting to explore whether this increase in risk is related to positive or negative changes in shareholder value. If managers were failing to pursue positive NPV projects due to risk aversion and stock options counterbalance the effect, that is all to the good. But if managers were already taking advantage of all value-enhancing projects, then options may incentivize managers to pursue bad projects just to create risk.

Table 8 attempts to determine which case is more common. The findings in section III.D appear to indicate that options encourage increases in leverage. This section takes a closer look at the effects of executive stock options on shareholder value by exploring the relation between changes in total wealth elasticity and subsequent stock market returns controlling for changes in volatility.

The table reports the results from a regression model whose dependent variable is annual stock return for year t. As explanatory variables, we use wealth elasticity at the beginning of the year, changes in volatility during the year, and the interaction of the two, plus the usual controls and fixed effects. The coefficient on changes in volatility is negative and highly significant, which is consistent with the well-known negative contemporaneous correlation between returns and volatility changes. The more interesting effects are the wealth elasticity and the interaction term. The first is positive; the second is negative.

The positive coefficient on wealth elasticity means that option grants tend to increase stock price (coefficient .130; t-statistic 3.60). Our standard large option grant implying a .36 elasticity generates approximately a 4% stock return, controlling for all other effects. However, the interaction term has the opposite sign (-.34; t-statistic 6.04). This appears to imply that when option-based incentives cause managers to increase firm volatility, this hurts the stock's performance. Options can help motivate managers to act in ways that create shareholder value, but increasing firm volatility does not appear to be one of those things.

## IV. Conclusions

This paper examines the risk-taking incentives created by executive stock options and the way in which managers respond to those incentives. Stock option values are increasing in firm stock price volatility. If executives respond to the risk-taking incentives created by their option holdings, the response could take either of two forms. Executive option holdings may reduce the agency problem if risk-averse managers who have large undiversified holdings of financial and human capital in the firm maximize their own utility by reducing firm volatility. Alternatively, option grants may have a negative effect on shareholder value if they encourage managers to take on projects which have negative net present value but which increase stock price volatility.

We use a unique dataset (Hall and Liebman, 1998) to examine these issues. Our data includes precise measures of the option holdings of the CEOs of 478 large firms over a 15 year period. Our evidence indicates that managers do respond to these incentives. Controlling for other effects, executives with more options (and options that are more sensitive to volatility) increase the volatility of the firms they control. In particular, managers take the quickest route to increased volatility of stock price: they tend to increase firm leverage in response to increases in their wealth's sensitivity to volatility. These effects occur despite careful controls, including controls for CEO and firm characteristics as well as firm and year fixed effects. Though causality is notoriously difficult to ascertain in such circumstances, our evidence indicates that option grants cause volatility

rather than the reverse. However, although statistically significant and robust, the estimated effect on risk-taking seems to be modest in magnitude.

Finally, we test to see whether the risk-increasing measures taken by executives generate positive or negative returns to stockholders. We find that option grants themselves lead to superior firm performance. But when increased option holdings lead to increases in firm volatility, the market response is insignificant. We conclude that the risk-taking incentives created by executive stock options leads to only modest increases in firm risk, which neither impose costs nor provide benefits to shareholders.

## V. References


Abowd, John M. and David S. Kaplan, "Executive Compensation: Six Questions that Need Answering," *Journal of Economic Perspectives*, Number 4, Fall 1999.

Aggarwal, Rajesh K. and Andrew Samwick, "The Other Side of the Trade-off: The impact of Risk on Executive Compensation," *Journal of Political Economy*, 1999, 107(1), 65-105.

Black, Fischer and Scholes, Myron. "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy*, 1973, 81, 637-59.

Baker, George P., Michael C. Jensen and Kevin J. Murphy, "Compensation and Incentives: Practice and Theory," *Journal of Finance*, 43(3), (1988), 593-616.

Carpenter, Jennifer N., "The Exercise and Valuation of Executive Stock Options," *Journal of Financial Economics*, 1998.

Chance, Don M., Raman Kumar and Rebecca B. Todd, "The Repricing of Executive Stock Options," draft, March 1997.

Esty, Benjamin C., "A Case Study of Organizational Form and Risk Shifting in Savings and Loan Industry," *Journal of Financial Economics*, vol. 44, no. 1, 1997, pp. 57-76.

Fama, Eugene F. and Kenneth R. French, "Disappearing Dividends: Changing Firm Characteristics or Increased Reluctance to Pay?," Unpublished paper, University of Chicago and MIT, 1999.

Gilson, Stuart C. and Michael R. Vetsuypens, "CEO Compensation in Financially Distressed Firms: An Empirical Analysis," *Journal of Finance*, 48(2), (1993), 425-458.

Guay, Wayne R., "The Sensitivity of CEO Wealth to Equity Risk: An Analysis of the Magnitude and Determinants." *Journal of Financial Economics*, 1999.

Hall, Brian J., "What You Need to Know About Stock Options," Harvard Business Review, March-April 2000.

Hall, Brian J. and Leibman, Jeffrey B. "Are CEOs Really Paid Like Bureaucrats?" *Quarterly Journal of Economics*, 1998, 113(3): 653-691.

Haubrich, Joseph G., "Risk Aversion, Performance Pay and the Principal-Agent Problem," *Journal of Political Economy*, 102(2), (1994), 258-276.

Holmstrom, Bengt, "Moral Hazard and Observability," *Bell Journal of Economics*, 10, (1979), 74-91.Jensen, Michael C. and William M. Meckling, "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure," *Journal of Financial Economics*, 3, (1976), 305-360.

Jensen, Michael C. and Kevin J. Murphy, "Performance Pay and Top-Management Incentives," *Journal of Political Economy*, 1990, 98(2) pp. 225-64.

Jolls, Christine, "Stock Repurchases and Incentive Compensation," NBER Working Paper, March 1998.

Lambert, Richard A.; Larcker, David F. and Verrecchia, Robert E., "Portfolio Considerations in Valuing Executive Compensation," *Journal of Accounting Research*, 1991, 29(1), 129-49.

Lewellen, Wilbur G., *Executive Compensation in Large Industrial Corporations*, National Bureau of Economic Research, (Chicago: University of Chicago Press, 1968).

Merton, Robert C., "Theory of Rational Option Pricing," *Bell Journal of Economics and Management Science*, IV, 1973, 141-183.

Merton, Robert C., Continuous-Time Finance, Blackwell Publishers Ltd., 1997.

Murphy, Kevin J. "Executive Compensation," in Orley Ashenfelter and David Card, eds., Handbook of Labor Economics, Vol. III, North Holland, 1999.

Rosen, Sherwin, "Contracts and the Market for Executives," in *Contract Economics*, in Werin, Lars and Hans Wijkander, eds., (Cambridge, MA: Blackwell, 1992), 181-211.

Tufano, Peter, "The Determinants of Stock Price Exposure: Financial Engineering and the Gold Mining Industry," *Journal of Finance*, (1998), 1015-1052.

U.S. Securities and Exchange Commission, 1993, Release No. 33-7009 (August 6) (SEC, 1993).

Warner, Jerold, Ross Watts and Karen Wruck, "Stock Prices and Top Management Changes," *Journal of Financial Economics*, 20, (1988), 461-492.

Weisbach, Michael, "Outside Directors and CEO Turnover," *Journal of Financial Economics*, (1988), 431-460.

Yermack, David, "Do Corporations Award CEO Stock Options Effectively?," *Journal of Financial Economics*, 39(2-3), (1995), 237-69.

**Table 1**
**Summary of Data**

Table 1 presents summary statistics for the variables used in Tables 2 through 8. Each panel of the table reports the sample mean, standard deviation, median, 1st percentile and 99th percentile for each of the variables. Panel A computes these sample moments for the whole sample, while Panel B does it for the last year in the sample (1994). Wealth elasticity is the total CEO wealth elasticity with respect to stock return volatility. Wealth is measured as the value of CEO stock and option holdings of the firm. The computation of this elasticity as well as options values is based on the Black-Scholes formula. Salary and bonus are annual. Volatility is based on daily returns for the last six months of the firm fiscal year and then annualized. Return and volatility are based on data from CRSP. Leverage is defined as the ratio between interest bearing debt and equity. The source of the data for leverage is COMPUSTAT.

**(A) Full Sample**

| | Mean | S.D. | Median | 1% | 99% |
|---|---|---|---|---|---|
| Wealth Elasticity | 0.124 | 0.294 | 0.0517 | 0.0 | 0.756 |
| Option value + stock value (mil.) | 34.5 | 246 | 3.11 | 0.00 | 509 |
| Salary + bonus (000s) | 752.520 | 639.580 | 598.000 | 125.000 | 3200.000 |
| Firm market value (bil.) | 2.5 | 4.94 | 1.07 | 0.022 | 23.5 |
| CEO Tenure (years) | 8.56 | 7.25 | 6.00 | 1.00 | 33.00 |
| CEO Age (years) | 57.12 | 6.64 | 58.00 | 40.00 | 73.00 |
| Volatility (% per year) | 31.6 | 18.9 | 27.1 | 10.8 | 96.6 |
| Return (% per year) | 8.56 | 7.25 | 6.00 | 1.00 | 33.00 |
| Leverage (D/E) | 1.51 | 5.73 | 0.51 | 0.00 | 17.02 |

**(B) Year 1994**

| | Mean | S.D. | Median | 1% | 99% |
|---|---|---|---|---|---|
| Wealth Elasticity | 0.189 | 0.200 | 0.141 | 0.0 | 0.897 |
| Option value + stock value (mil.) | 97.5 | 711 | 9.38 | 0.161 | 1170 |
| Salary + bonus (000s) | 1289.800 | 1163.040 | 1050.000 | 305.000 | 5050.000 |
| Firm market value (bil.) | 4.63 | 7.58 | 2.17 | 0.061 | 36.5 |
| CEO Tenure (years) | 8.47 | 7.28 | 6.00 | 1.00 | 35.00 |
| CEO Age (years) | 57.59 | 6.65 | 58.00 | 39.00 | 78.00 |
| Volatility (% per year) | 25.4 | 10.2 | 23.3 | 11.7 | 74.2 |
| Return (% per year) | -0.81 | 20.9 | -2.41 | -54.5 | 66.1 |
| Leverage (D/E) | 1.09 | 2.33 | 0.53 | 0.00 | 9.05 |

**Table 2**
**Regressions of Total Firm Volatility ($\sigma$)**
**on CEO Wealth Elasticity with Respect to $\sigma$**

Table 2 reports the results from a regression of total firm volatility on CEO wealth elasticity with respect to volatility. Volatility is measured using daily returns over the last six months of the firm fiscal year and then annualized. All other variables are measured at the end of the previous fiscal year. Tenure and age are in thousands, and the rest of the parameters are in natural units. Table 1 describes these variables. Table 2 has four columns. The first two columns present regression results that do not control for fixed firm and year effects in the sample, while the last two columns do control for these effects. Columns labeled LS present results for robust least-square regressions, while columns labeled Median present results for median regressions. Standard errors (in parentheses) are White errors. The sample period is 1980 through 1994, and it includes 5612 firm-year observations. An * indicates that the parameter is significant at the 5% level, and a ** indicates that the parameter is significant at the 1% level.

| | **Ordinary Regressions** | | **Firm Effects and Year Dummies** | |
|---|---|---|---|---|
| | **LS** | **Median** | **LS** | **Median** |
| Wealth Elasticity | 0.077 | 0.087 | 0.024 | 0.030 |
| | (8.86)** | (8.54)** | (3.36)** | (4.39)** |
| Log(option value + stock value) | 0.016 | 0.016 | 0.004 | 0.004 |
| | (17.67)** | (15.39)** | (3.43)** | (3.56)** |
| Log(salary + bonus) | 0.011 | 0.015 | -0.006 | -0.004 |
| | (3.75)** | (4.63)** | (1.51) | (1.01) |
| Log (firm market value) | -0.028 | -0.034 | -0.029 | -0.036 |
| | (21.24)** | (22.57)** | (12.69)** | (16.41)** |
| CEO Tenure | 0.309 | 0.205 | 0.265 | 0.330 |
| | (1.28) | (0.73) | (0.89) | (1.16) |
| CEO Age | -2.233 | -2.425 | -0.457 | -0.392 |
| | (9.44)** | (8.74)** | (1.56) | (1.40) |
| Constant | 0.660 | 0.775 | -0.044 | -0.051 |
| | (28.13)** | (28.12)** | (9.19)** | (11.26)** |

**Table 3**
**Regressions of Total Firm Volatility (σ)**
**on CEO Wealth Elasticity Calculated without Current Year's Option Grants**

Table 3 reports the results from a regression of total firm volatility on CEO wealth elasticity with respect to volatility calculated without current year's options grants. Volatility is measured using daily returns over the last six months of the firm fiscal year and then annualized. All other variables are measured at the end of the previous fiscal year. Tenure and age are in thousands, and the rest of the parameters are in natural units. Table 1 describes these variables. Table 3 has four columns. The first two columns present regression results that do not control for fixed firm and year effects in the sample, while the last two columns do control for these effects. Columns labeled LS present results for robust least-square regressions, while columns labeled Median present results for median regressions. Standard errors (in parentheses) are White errors. The sample period is 1980 through 1994, and it includes 5612 firm-year observations. An * indicates that the parameter is significant at the 5% level, and a ** indicates that the parameter is significant at the 1% level.

| | **Ordinary Regressions** | | **Firm Effects and Year Dummies** | |
|---|---|---|---|---|
| | **LS** | **Median** | **LS** | **Median** |
| Wealth Elasticity | 0.096 | 0.089 | 0.051 | 0.036 |
| | (12.54)** | (14.01)** | (11.68)** | (7.73)** |
| Log(option value + stock value) | 0.016 | 0.016 | 0.005 | 0.004 |
| | (18.01)** | (15.44)** | (4.29)** | (2.72)** |
| Log(salary + bonus) | 0.010 | 0.015 | -0.006 | -0.004 |
| | (3.49)** | (4.45)** | (1.52) | (1.02) |
| Log (firm market value) | -0.027 | -0.033 | -0.029 | -0.034 |
| | (20.86)** | (21.79)** | (12.37)** | (13.24)** |
| CEO Tenure | 0.333 | 0.188 | 0.177 | 0.168 |
| | (1.39) | (0.67) | (0.59) | (0.51) |
| CEO Age | -2.190 | -2.336 | -0.276 | -0.162 |
| | (9.22)** | (8.40)** | (0.94) | (0.51) |
| Constant | 0.654 | 0.758 | -0.042 | -0.050 |
| | (27.61)** | (27.32)** | (8.83)** | (9.78)** |

**Table 4**
**Regressions of Total Firm Volatility ($\sigma$)**
**on CEO Wealth Elasticity with Respect to $\sigma$ and Lagged Volatility**

Table 4 reports the results from a regression of total firm volatility on CEO wealth elasticity with respect to volatility and lagged volatility. Volatility is measured using daily returns over the last six months of the firm fiscal year and then annualized. All other variables are measured at the end of the previous fiscal year. Tenure and age are in thousands, and the rest of the parameters are in natural units. Table 1 describes these variables. Table 4 has four columns. The first two columns present regression results that do not control for fixed firm and year effects in the sample, while the last two columns do control for these effects. Columns labeled LS present results for robust least-square regressions, while columns labeled Median present results for median regressions. Standard errors (in parentheses) are White errors. The sample period is 1980 through 1994, and it includes 5612 firm-year observations. An * indicates that the parameter is significant at the 5% level, and a ** indicates that the parameter is significant at the 1% level.

| | **Ordinary Regressions** | | **Firm Effects and Year Dummies** | |
|---|---|---|---|---|
| | **LS** | **Median** | **LS** | **Median** |
| Wealth Elasticity | 0.006 | 0.008 | 0.018 | 0.029 |
| | (1.52) | (1.70)* | (5.82)** | (9.27)** |
| Lagged Volatility | 0.321 | 0.410 | 0.198 | 0.180 |
| | (33.89)** | (39.51)** | (19.53)** | (17.01)** |
| Log(option value + stock value) | 0.010 | 0.010 | 0.004 | 0.005 |
| | (11.73)** | (10.17)** | (3.43)** | (3.59)* |
| Log(salary + bonus) | 0.006 | 0.009 | -0.003 | -0.003 |
| | (2.29)** | (2.92)** | (0.83) | (0.73) |
| Log (firm market value) | -0.020 | -0.022 | -0.028 | -0.033 |
| | (15.79)** | (15.76)** | (11.73)** | (13.26)** |
| CEO Tenure | -0.143 | -0.282 | 0.265 | 0.091 |
| | (0.64) | (1.15) | (0.89) | (0.29) |
| CEO Age | -1.381 | -1.253 | -0.524 | -0.150 |
| | (6.10)** | (5.05)** | (1.80)* | (0.49) |
| Constant | 0.491 | 0.488 | -0.039 | -0.039 |
| | (20.53)** | (18.63)** | (9.02)** | (8.59)** |

**Table 5**
**Regressions of Firm Systematic Risk ($\beta\sigma(\mathbf{r_m})$)**
**on CEO Wealth Elasticity with Respect to $\sigma$**

Table 5 reports the results from a regression of firm systematic risk on CEO wealth elasticity with respect to volatility. Systematic risk is measured as the standard deviation of the product of the firm beta times the market daily excess returns over the last six months of the firm fiscal year and then annualized. We proxy for the market return with the total return on the CRSP value-weighted portfolio. We use returns on a one-moth T-Bill as a proxy for the short rate in our computation of excess market returns. We use the annual estimates of firm beta provided in the CRSP tape. All other variables are measured at the end of the previous fiscal year. Tenure and age are in thousands, and the rest of the parameters are in natural units. Table 1 describes these variables. Table 5 has four columns. The first two columns present regression results that do not control for fixed firm and year effects in the sample, while the last two columns do control for these effects. Columns labeled LS present results for robust least-square regressions, while columns labeled Median present results for median regressions. Standard errors (in parentheses) are White errors. The sample period is 1980 through 1994, and it includes 5612 firm-year observations. An * indicates that the parameter is significant at the 5% level, and a ** indicates that the parameter is significant at the 1% level.

| | **Ordinary Regressions** | | **Firm Effects and Year Dummies** | |
|---|---|---|---|---|
| | **LS** | **Median** | **LS** | **Median** |
| Wealth Elasticity | 0.011 | 0.020 | -0.011 | -0.005 |
| | (1.95)* | (3.16)** | (2.41)** | (0.77) |
| Log(option value + stock value) | 5.081 | 3.159 | 2.507 | 0.516 |
| | (8.67)** | (4.82)** | (3.36)** | (0.48) |
| Log(salary + bonus) | 12.597 | 20.443 | 2.193 | 5.102 |
| | (6.78)** | (9.85)** | (0.98) | (1.59) |
| Log (firm market value) | -4.200 | 0.815 | 8.358 | 15.556 |
| | (4.98)** | (0.86) | (5.99)** | (7.79)** |
| CEO Tenure | 0.466 | 0.731 | 0.496 | 0.882 |
| | (2.98)** | (4.18)** | (2.76)** | (3.44)** |
| CEO Age | -0.667 | -0.485 | -0.543 | -0.562 |
| | (4.33)** | (2.81)** | (3.09)** | (2.24)* |
| Constant | 0.083 | -0.070 | 0.013 | 0.008 |
| | (5.46)** | (4.08)** | (4.39)** | (1.99)* |

**Table 6**
**Regressions of Firm Idiosyncratic Risk ($\sigma(\mathbf{r}-\beta\mathbf{r}_m)$)**
**on CEO Wealth Elasticity with Respect to $\sigma$**

Table 6 reports the results from a regression of firm idisyncratic risk on CEO wealth elasticity with respect to volatility. Idiosyncratic risk is measured as the standard deviation of the difference between firm excess stock return and the firm beta times the market daily excess returns over the last six months of the firm fiscal year and then annualized. We proxy for the market return with the total return on the CRSP value-weighted portfolio. We use returns on a one-moth T-Bill as a proxy for the short rate in our computation of excess market returns. We use the annual estimates of firm beta provided in the CRSP tape. All other variables are measured at the end of the previous fiscal year. Tenure and age are in thousands, and the rest of the parameters are in natural units. Table 1 describes these variables. Table 6 has four columns. The first two columns present regression results that do not control for fixed firm and year effects in the sample, while the last two columns do control for these effects. Columns labeled LS present results for robust least-square regressions, while columns labeled Median present results for median regressions. Standard errors (in parentheses) are White errors. The sample period is 1980 through 1994, and it includes 5612 firm-year observations. An * indicates that the parameter is significant at the 5% level, and a ** indicates that the parameter is significant at the 1% level.

| | **Ordinary Regressions** | | **Firm Effects and Year Dummies** | |
|---|---|---|---|---|
| | **LS** | **Median** | **LS** | **Median** |
| Wealth Elasticity | 0.094 | 0.100 | 0.048 | 0.032 |
| | (14.31)** | (11.94)** | (7.79)** | (3.35)** |
| Log(option value + stock value) | 15.186 | 19.220 | 3.490 | 3.263 |
| | (22.18)** | (22.12)** | (3.28)** | (2.00)* |
| Log(salary + bonus) | 9.210 | 2.527 | -3.126 | -4.980 |
| | (4.24)** | (0.92) | (0.98) | (1.02) |
| Log (firm market value) | -37.491 | -50.852 | -35.860 | -49.987 |
| | (38.00)** | (40.61)** | (18.02)** | (16.39)** |
| CEO Tenure | 0.073 | -0.850 | -0.124 | -0.836 |
| | (0.40) | (3.67)** | (0.48) | (2.13)* |
| CEO Age | -1.881 | -1.925 | 0.303 | 0.630 |
| | (10.44)** | (8.41)** | (1.21) | (1.64) |
| Constant | 0.852 | 1.135 | -0.006 | -0.026 |
| | (47.63)** | (49.97)** | (1.58) | (4.13)** |

**Table 7**
**Regressions of Log(Leverage)**
**on CEO Wealth Elasticity with Respect to σ**

Table 7 reports the results from a regression of the log of firm leverage on CEO wealth elasticity with respect to volatility. Leverage is measured as the ratio of interest bearing debt and equity, using data from COMPUSTAT, at the end of the fiscal year. All other variables are measured at the end of the previous fiscal year. Tenure and age are in thousands, and the rest of the parameters are in natural units. Table 1 describes these variables. Table 7 has four columns. The first two columns present regression results that do not control for fixed firm and year effects in the sample, while the last two columns do control for these effects. Columns labeled LS present results for robust least-square regressions, while columns labeled Median present results for median regressions. Standard errors (in parentheses) are White errors. The sample period is 1980 through 1994, and it includes 5612 firm-year observations. An * indicates that the parameter is significant at the 5% level, and a ** indicates that the parameter is significant at the 1% level.

| | **Ordinary Regressions** | | **Firm Effects and Year Dummies** | |
|---|---|---|---|---|
| | **LS** | **Median** | **LS** | **Median** |
| Wealth Elasticity | 0.528 | 0.280 | 0.091 | 0.163 |
| | (4.67)** | (2.22)* | (1.91)* | (3.32)** |
| Log(option value + stock value) | -0.251 | -0.263 | -0.006 | -0.002 |
| | (20.79)** | (19.54)** | (0.69) | (0.18) |
| Log(salary + bonus) | 0.591 | 0.415 | 0.051 | 0.027 |
| | (15.64)** | (9.85)** | (2.07)* | (1.06) |
| Log (firm market value) | -0.449 | -0.309 | -0.624 | -0.591 |
| | (26.39)** | (16.33)** | (40.93)** | (37.45)** |
| CEO Tenure | 0.014 | 0.016 | -0.003 | -0.007 |
| | (4.47)** | (4.64)** | (1.45) | (3.31)** |
| CEO Age | -0.009 | -0.002 | 0.005 | 0.008 |
| | (2.98)** | (0.47) | (2.68)** | (4.03)** |
| Constant | 4.996 | 4.111 | -0.246 | -0.218 |
| | (12.69)** | (9.37)** | (7.84)** | (6.71)** |

**Table 8**
**Regressions of Annual Returns**
**on CEO Wealth Elasticity with Respect to σ**

Table 8 reports the results from a regression of firm stock return on CEO wealth elasticity with respect to volatility. Firm stock return is measured over the last six months of the firm fiscal year and then annualized. All other variables are measured at the end of the previous fiscal year. Tenure and age are in thousands, and the rest of the parameters are in natural units. Table 1 describes these variables. Table 8 has four columns. The first two columns present regression results that do not control for fixed firm and year effects in the sample, while the last two columns do control for these effects. Columns labeled LS present results for robust least-square regressions, while columns labeled Median present results for median regressions. Standard errors (in parentheses) are White errors. The sample period is 1980 through 1994, and it includes 5612 firm-year observations. An * indicates that the parameter is significant at the 5% level, and a ** indicates that the parameter is significant at the 1% level.

| | **Ordinary Regressions** | | **Firm Effects and Year Dummies** | |
|---|---|---|---|---|
| | **LS** | **Quantile** | **LS** | **Quantile** |
| Wealth Elasticity at start of year | -0.070 | -0.036 | 0.066 | 0.085 |
| | (1.87)* | (0.91) | (1.87)* | (2.11)* |
| σ at end of year | -0.580 | -0.476 | -0.363 | -0.289 |
| | (20.28)** | (14.70)** | (11.88)** | (8.27)** |
| σ*(Wealth Elasticity) | 0.012 | -0.060 | 0.078 | 0.022 |
| | (0.17) | (1.01) | (2.29)* | (0.58) |
| Log(option value + stock value) | -0.013 | -0.014 | -0.056 | -0.058 |
| | (5.18)** | (4.72)** | (13.03)** | (11.95)** |
| Log(salary + bonus) | -0.008 | -0.007 | 0.034 | 0.024 |
| | (0.94) | (0.76) | (2.66)** | (1.61) |
| Log (firm market value) | 0.022 | 0.015 | 0.135 | 0.134 |
| | (5.57)** | (3.25)** | (15.96)** | (13.83)** |
| CEO Tenure | 0.003 | 0.003 | 0.003 | 0.004 |
| | (4.18)** | (3.95)** | (2.85)** | (3.21)** |
| CEO Age | -0.002 | -0.002 | 0.000 | -0.001 |
| | (3.54)** | (3.03)** | (0.46) | (0.73) |
| Constant | 0.223 | 0.338 | 0.076 | 0.055 |
| | (3.11)** | (4.01)** | (4.65)** | (2.93)** |

**Figure 1. Median Wealth Elasticity Over Time.**

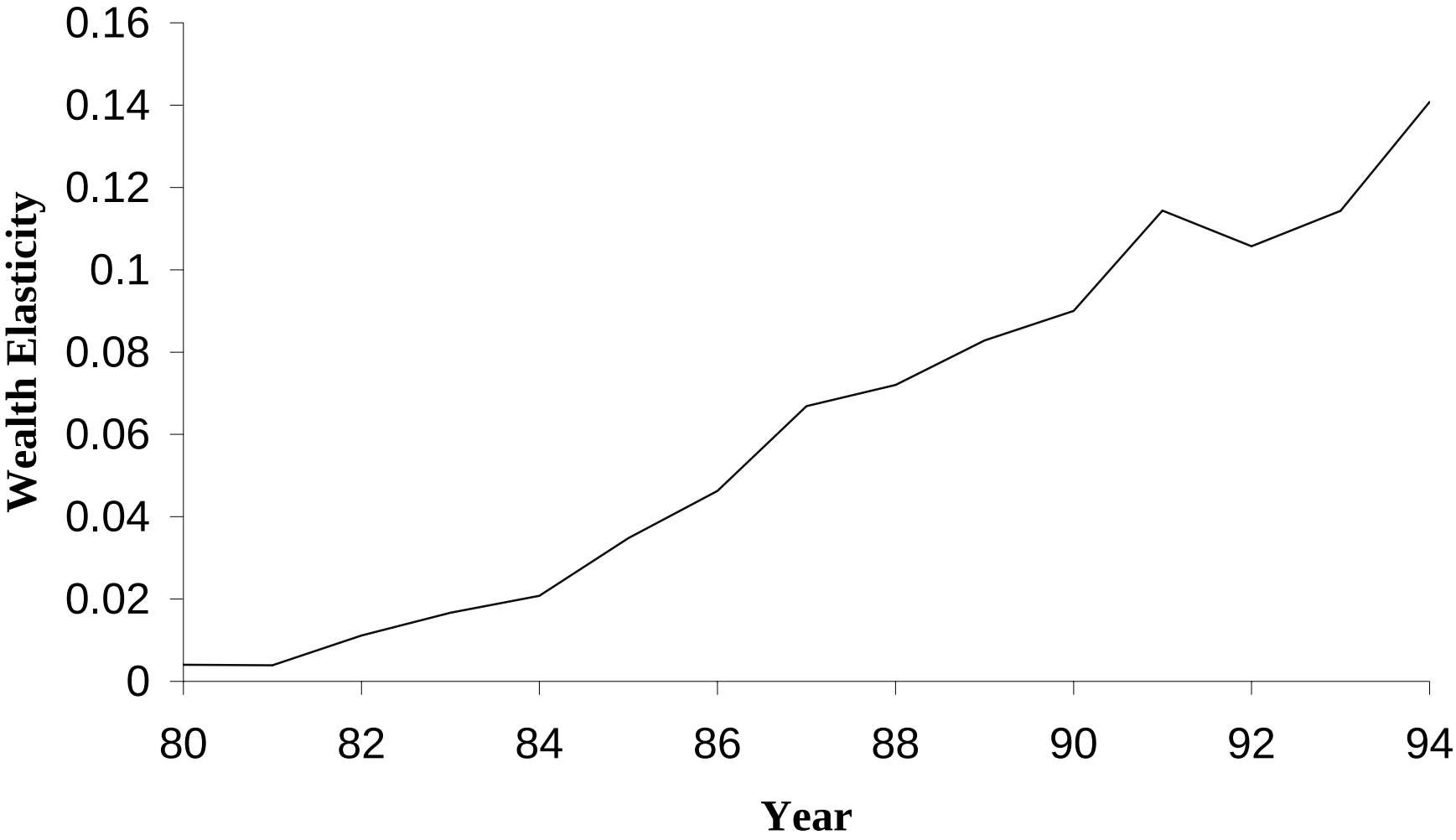

**Figure 2. Mean Fraction of Financial Wealth in Options Over Time**

**Figure 3. Wealth Elasticity Vs. Volatility**