# MIT Sloan School of Management

## Working Paper 4438-03
## September 2003

# Financing Decisions When Managers Are Risk Averse

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August 2003

I am grateful to my dissertation committee, Mike Barclay, Jerry Warner, and Jim Brickley, for guidance and encouragement. This paper has also benefited from the comments of Liz Demers, Ken French, Wayne Guay, Jon Lewellen, Lisa Meulbroek, Stew Myers, Bill Schwert, Anna Pavlova, Steve Ross, René Stulz, Dimitri Vayanos, Ross Watts, and workshop participants at Boston College, University of Colorado, Dartmouth, Duke, HBS, MIT, University of North Carolina, University of Rochester, and Wharton.

**Financing Decisions When Managers Are Risk Averse**

**Abstract**

This paper studies the impact of financing decisions on risk-averse managers. Leverage raises stock volatility, driving a wedge between the cost of debt to shareholders and the cost to undiversified, risk-averse managers. I quantify these 'volatility costs' of debt and examine their impact on financing decisions. The paper finds: (1) the volatility costs of debt can be large, particularly if the CEO owns in-the-money options; (2) higher option ownership tends to increase, not decrease, the volatility costs of debt; (3) a stock price increase typically reduces managerial preference for leverage, consistent with prior evidence on security issues. Empirically, I estimate the volatility costs of debt for a large sample of U.S. firms and test whether these costs affect financing decisions. I find strong evidence that volatility costs affect both the level of and short-term changes in debt. Further, a probit model of security issues suggests that managerial preferences help explain a firm's choice between debt and equity.

# 1 Introduction

Financial economists have long recognized that firms' financing decisions affect managers differently than shareholders. One difference arises because stock-based compensation exposes managers to firm-specific risk, giving them an incentive to keep debt levels low. In this paper, I study how different components of compensation, notably stocks and options, affect managers' incentives to raise or lower debt. I also test whether managers' incentives help explain actual financing decisions for a large sample of U.S. firms.

The first part of the paper explores, from a theoretical perspective, how leverage affects CEOs through its impact on stock volatility. CEO welfare is measured as the certainty equivalent of wealth (CE), to account for the manager's risk aversion, so the impact of a change in debt is simply the associated change in CE. I refer to this quantity as the manager's 'financing incentives' or the 'volatility costs' of debt. For the initial analysis, I compute incentives for the median CEO in a sample of large U.S. companies from 1993 – 2001. I then vary the portfolio holdings of the manager, his risk aversion and outside wealth, and relevant firm characteristics to explore how incentives depend on various parameters.

The analysis provides several key insights. First, the volatility costs of debt to executives can be large, particularly when the CEO owns in-the-money options. Researchers often argue that options, because of their convexity, encourage managerial risk taking (e.g., Haugen and Senbet, 1981; Smith and Watts, 1982; Smith and Stulz, 1985). This reasoning, in fact, underlies prior research on the relation between compensation and leverage (discussed below). In contrast, I show that options will often significantly *discourage* risk taking and leverage. The effect is strongest when in-the-money options make up a large fraction of the portfolio. Suppose, for example, that the CEO owns 100,000 shares and 600,000 options with a price-to-strike ratio of 1.3 (the other parameters equal the median values for my sample). If the CEO has power utility with relative risk aversion of two and 90% of his wealth invested in the firm, his CE of wealth drops by 4.9% as a result of an increase in leverage by 10 percentage points. In comparison, the effect would be 1.2% if the CEO owns only shares with the same market value.

The magnitude of financing incentives depends on the CEO's risk aversion and outside wealth, which are generally unknown for empirical applications. However, I find that the *direction* of incentives, as well as key comparative statics, are fairly robust to different assumptions about these parameters. Most important, incentives estimated under different assumptions are highly correlated with each other for the sample of firms used in the empirical analysis. (Interestingly, the cross-sectional patterns are often reversed when incentives are measured using Black-Scholes.) I also show, using an analytical framework like that of Ross (2003), that the qualitative conclusions appear to be quite general.

The theoretical results suggest that stock-based compensation can make debt financing quite costly to executives. Perhaps a more important question is whether these costs influence actual financing decisions. There are at least two reasons that managers' incentives could be important. First, managers might have discretion over capital structure because of imperfections in corporate governance. For example, the board of directors might fail to adequately represent shareholders' interests, perhaps because board members themselves prefer lower debt. Second, managers might influence leverage because they have better information than shareholders about the costs and benefits of debt. If it is costly to perfectly align managers' incentives with those of shareholders, leverage could temporarily deviate from its value-maximizing level in response to changes in managerial financing incentives. Optimally, it would be useful to distinguish between these two hypotheses, but the goal of this paper is more modest, to test whether managers' incentives help explain observed financing choices.

To investigate these issues, I estimate financing incentives for 1,587 large U.S. companies during the period 1993 – 2001. For each firm, I collect detailed compensation data from Standard & Poor's Execucomp database. The data allow me to reconstruct the CEO's portfolio in each year. Using this information, I estimate financing incentives under various assumptions about CEO risk aversion and outside wealth. I then test, in several ways, whether incentives help explain time-series and cross-sectional variation in financing choices.

The first set of tests focus on firms that issue debt or equity in a given year (similar to the approach of Mackie-Mason, 1990). I test whether, conditional on the decision to raise outside funds, managers with stronger incentives to increase leverage are more likely to issue debt than equity. I find that financing incentives are positively and significantly associated with the probability of a debt issue. An increase in incentives by one standard deviation increases the probability of a debt issue by approximately 6 percentage points. The results remain significant when the regressions include factors that are correlated with incentives, like executive ownership, firm value, and stock volatility, as well as other controls.

As a second test, I ask whether executives who experience an increase in volatility costs are more or less likely to subsequently increase leverage. I regress debt changes on lagged changes in incentives and other determinants of debt. The debt-changes regressions provide additional evidence that volatility costs affect financing decisions.

Finally, I examine cross-sectional variation in debt levels. A complication with these tests is that financing incentives depend directly on a firm's leverage. To avoid a reverse-causality problem, I estimate what financing incentives would be if the firm had no leverage, instead of at the actual leverage. I also try to account for the endogeneity of executive ownership and leverage by modeling these variables in a system of simultaneous equations. The regressions again suggest that incentives are an important determinant of leverage. The results appear robust and remain significant after controlling for both cross-sectional and serial correlation in the residuals. Overall, the evidence suggests that managerial incentives have an economically meaningful impact on financing decisions.

This paper is not the first to explore the relation between leverage and compensation, but prior research does not try to quantify financing incentives. Instead, studies have focused on stock and option ownership. Agrawal and Mandelker (1987) find that CEOs with higher stock and option holdings are more likely to undertake leverage- and volatility-increasing acquisitions. DeFusco, Johnson, and Zorn (1990) show that stock volatility increases after the approval of stock option plans. Mehran (1992) finds a positive relation between option holdings and leverage, while Tufano (1996) finds a negative relation between option holdings and hedging activities. These studies argue that incentive compensation encourage risk taking and higher levels of debt, contrary to my theoretical results.[1] In the same spirit, Guay (1999), Cohen, Hall, and Viceira (2000), Rajgopal and Shevlin (2002), and Knopf, Nam, and Thornton (2002) analyze managerial risk incentives using the Black-Scholes model. My results show that this approach can be quite misleading when applied to undiversified, risk-averse executives.

A few recent studies do take into account managers' risk aversion, but most do not investigate risk incentives. Instead, they focus on option valuation and the pay-for-performance incentives associated with options (e.g., Detemple and Sundaresan, 1999; Meulbroek, 2000; and Hall and Murphy, 2002). Three exceptions are Lambert, Larcker, and Verrecchia (1991), Carpenter (2000), and Ross (2003). Lambert et al. point out that, when executives are risk averse, options can either encourage or discourage risk taking. Ross describes general conditions under which incentive schedules make agents more or less risk averse. Carpenter derives the optimal trading strategy for a portfolio manager who trades continuously and is compensated with a convex payoff. The results on risk incentives in these three papers are consistent with mine, but the studies do not analyze executives' leverage choices or risk incentives for actual firms, or test their importance empirically.

[1] Friend and Lang (1988) and Agrawal and Nagarajan (1990) find the opposite. However, both papers consider only managerial ownership of stocks, rather than stocks and options.

The paper is organized as follows. Section 2 explores the impact of financing decisions on risk-averse managers. It defines financing incentives and shows how incentives depend on the CEO's portfolio and firm characteristics. Section 3 discusses the hypotheses for the empirical tests. Section 4 describes the data and provides descriptive evidence on financing incentives. Section 5 discusses the empirical results. Section 6 concludes.

## 2 How do leverage changes affect executives?

This section explores how stock-based compensation affects a manager's preference for stock volatility and leverage. A typical incentive contract includes options and restricted stock. Executive options are nontransferable and, in most cases, subject to vesting restrictions. Moreover, executives are prohibited by the SEC from shorting their own stock. These restrictions imply that managers will perceive risk differently than unconstrained shareholders; we cannot evaluate managers' attitudes towards risk and leverage simply by looking at the market value of their portfolio holdings. Instead, we must evaluate them "through the filter of [managers'] own personal preferences and tradeoff between risk and return" (Ross, 2003).

### 2.1 Measuring financing incentives

The basic approach is straightforward. Because I am interested in understanding the incentives induced by particular compensation schemes, I take the executive's portfolio holdings as given. I ask how a given change in leverage (e.g., by one percentage point) affects the certainty equivalent of the CEO's wealth through its impact on the mean and variance of stock returns. I begin with a benchmark firm that corresponds to the median firm in my sample (described later) with respect to all relevant parameters. Then, I vary the CEO's portfolio and firm's characteristics to show how incentives vary with these parameters.

In the main part of the paper, I rely on numerical methods because, given the assumptions below, there do not exist simple closed-form expressions for the results. However, I also provide analytical expressions for the effects of incentive contracts on managers' aversion to stock volatility using an approach suggested by Ross (2003) (see Appendix 1). The two approaches are complementary. The numerical analysis gives us a better understanding of the directions and magnitudes of financing incentives for typical firms. The appendix provides intuition where the risk incentives come from and how they are determined.

The goal is to document incentive effects for *actual firms* and for empirically observed incentive contracts. I have information on most relevant parameters for my sample firms, such as the composition of the manager's portfolio, current leverage, and stock return volatility. Unfortunately, two important inputs are generally not observed: managers' utility functions and their portfolio holdings outside the firm. I address this shortcoming in two ways. First, in the main part of the paper I choose a utility function – power utility – that is widely used in the literature because of its appealing properties (most important, it has constant relative risk aversion, or CRRA).[2] I show results for a wide range of risk-aversion parameters and outside-wealth assumptions. Second, I show analytically (in Appendix 1) that the qualitative conclusions are fairly general, and apply for a broad range of concave utility functions.

*Details of the estimation*

To estimate financing incentives, I measure CEO welfare as the certainty equivalent of wealth. CE is the amount of the riskless asset that provides the same utility as the actual portfolio. The impact of a leverage change on CEO welfare, denoted IC, is simply the associated change in CE. When leverage moves from $L^0$ to $L^1$, the change in CEO welfare is:

$$IC = CE(L^1) - CE(L^0) . \tag{1}$$

This quantity measures the manager's financing incentives.

To compute certainty equivalent, I must estimate the CEO's expected utility. CE is then given by the dollar amount that satisfies:

$$U(CE) = E\left[U(\tilde{W})\right], \tag{2}$$

where $\tilde{W}$ is the CEO's end-of-period wealth and $U(\cdot)$ is his utility function. In the main part of the paper I assume that the CEO has power utility with risk aversion parameter $\gamma$ (Appendix 1 discusses results for alternative utility functions):

$$U(W) = \frac{1}{1-\gamma} W^{(1-\gamma)} . \tag{3}$$

Expected utility cannot be calculated in closed form, so the analysis relies on numerical simulations. End-of-period wealth W is randomly generated as follows. Wealth depends on the CEO's portfolio and the distribution of stock prices. I assume that the CEO's wealth consists of the firm's stock and options, plus outside wealth invested in T-Bills (Appendix 3 shows how the results change when T-

[2] Examples of papers that use CRRA utility are: Mehra and Prescott (1985), Campbell (1993), Carpenter (1998), Lambert et al. (1991), Hall and Murphy (2002).

Bills are replaced by the market portfolio). At the end of the holding period (T), the CEO liquidates his entire portfolio. His end-of-period wealth is:

$$\widetilde{W}_T = \text{Stocks} \cdot \widetilde{P}_T + \sum_{i=1}^{n} \text{Options}_i \cdot \max(0, \widetilde{P}_T - X_i) + \text{Tbills}_T \,, \qquad (4)$$

where $\widetilde{P}_T$ is the end-of-period stock price, 'Stocks' is the number of shares held, and '$\text{Options}_i$' is the number of options with exercise price $X_i$. Most results are based on the assumption that the CEO exercises all options and sells all shares after a holding period of one year. The qualitative conclusions are similar for longer holding periods (see Appendix 3).

The simulations assume that stock returns, $1 + \widetilde{R}$, are log-normally distributed with mean $1 + \theta$ and standard deviation $\lambda$. To estimate $\theta$ and $\lambda$, I compute, for each firm and year in my sample, the annualized standard deviation and beta from weekly stock returns over the preceding three years. I use this sample standard deviation as a measure of $\lambda$, and I estimate $\theta$ assuming that stock returns are determined by CAPM. In the benchmark example in Section 2.2, the initial standard deviation and beta correspond to the median firm in my sample. Given these assumptions, the end-of-period stock price is given by:

$$\widetilde{P}_T = P_0 \cdot (1 + \widetilde{R}) \,. \qquad (5)$$

Leverage affects the manager through its impact on the mean and variance of stock returns. In the basic model, I adjust the mean and variance assuming that debt is riskless: the mean at the new leverage level $L^1$ is given by $\theta^1 = r + [(1 - L^0) / (1 - L^1)] (\theta - r)$, where r is the risk-free rate, and the standard deviation is $\lambda^1 = [(1 - L^0) / (1 - L^1)] \lambda$. This basic model should work well for firms with relatively safe debt but may not be appropriate for highly levered firms. As a robustness test, Appendix 2 presents an alternative approach that treats equity as a call option on the firm's assets and thus allows for risky debt. Since the conclusions are not sensitive to which model is used, most of the paper is based on the simpler model described in this section.

IC is designed to measure only a *partial* effect of a leverage change on CEO welfare, i.e., the component related to stock volatility. Therefore, I assume that leverage affects only the return distribution but leaves the current stock price unchanged. Thus, I intentionally omit other ways in which debt could affect the manager, for example, through its on expected bankruptcy costs, taxes, or agency costs (but the empirical tests later do control for these factors).

## 2.2 Numerical example

The benchmark example is based on the median firm in my sample (the sample is described in Section 4). Starting from this example, I analyze how financing incentives depend on firm characteristics and the CEO's portfolio. This analysis illustrates the magnitude and direction of incentive effects for a set of representative firms. It also helps us understand the properties of the incentive measure, the key variable for the empirical tests.

### *2.2.1 Parameters for the benchmark firm*

The parameters correspond roughly to the sample medians (Table 5, discussed later, shows the distribution of parameters for the sample and describes the sample in more detail). The benchmark firm has asset volatility of 28%, asset beta of 0.7, and market leverage of 15%. I assume that the CEO holds 200,000 options and 216,000 shares, so that the ratio of the number of shares to the number of options is close to the median ratio. The option exercise price is $30 and the current stock price is $40, which corresponds to the median price-to-strike ratio of 1.3. The market value of the stock and option portfolio, when options are valued using Black-Scholes model, is approximately $12 million, which is also close to the sample median.

### *2.2.2 Financing incentives for different stock and option portfolios*

To illustrate the basic arguments, Figure 1 compares incentives induced by stocks and options for my representative CEO. Financing incentives are defined as a percentage change in the certainty equivalent of CEO wealth caused by a 10% leverage increase (i.e., from 15% to 25%).[3] As a starting point, the CEO holds the median stock and option portfolio. Starting from the benchmark portfolio, I vary the parameters along two dimensions. First, I vary the number of options between zero and 600,000 (different curves in the graph) and adjust the number of shares to keep the portfolio value constant. Second, I vary the exercise price (moving along each curve), and adjust the number of stocks, options, and outside wealth proportionally to keep the portfolio value constant.[4] In the initial example, I assume that the CEO's risk-aversion coefficient is two and his outside wealth, invested in

[3] The size of the hypothetical leverage increase is not critical because I am interested in the *slope* of the leverage-CE relation rather than in the absolute magnitude of the CE change. As a robustness test, I repeat the analysis in Figure 1 assuming a 1% leverage increase. The resulting incentives estimates are roughly one-tenth of those reported in Figure 1.

[4] The results are similar when certainty equivalent of the portfolio is fixed, rather than Black-Scholes value. As an additional robustness check, I vary the exercise price and adjust the number of options so that the aggregate Black-Scholes value of *options* is constant along the curves (i.e., I keep the number of shares and T-Bills fixed). Again, the results are similar as those reported in Figure 1.

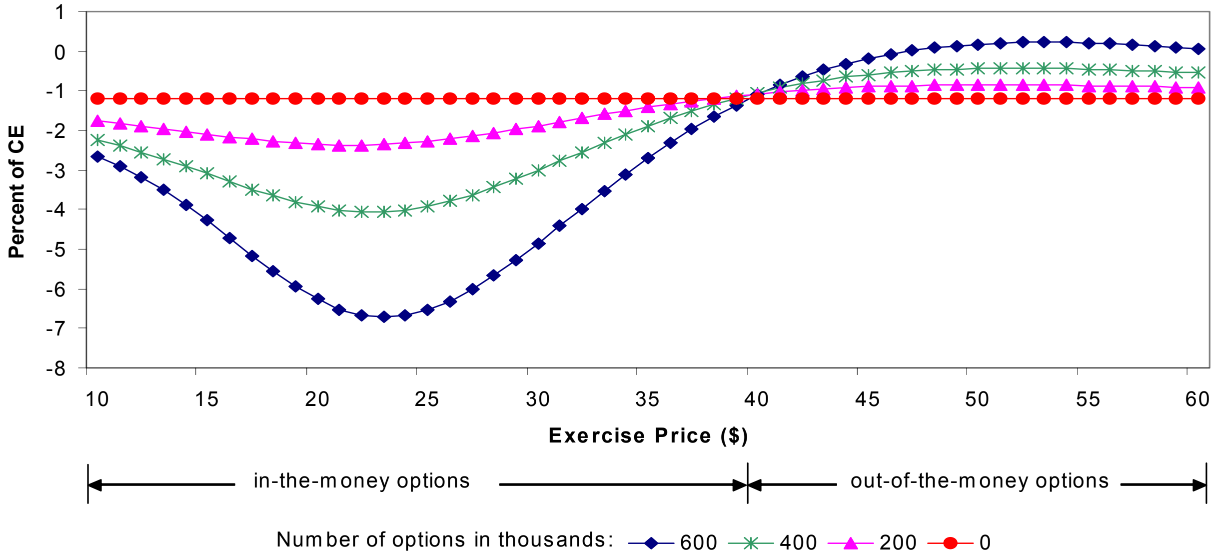


**Fig. 1: Financing incentives for different stock and option portfolios.** Financing incentives are measured as the percentage change in the certainty equivalent of CEO wealth caused by a 10 percentage point leverage increase. The CEO has power utility with a risk-aversion parameter of 2. In the base case, CEO holds 200,000 options, 216,000 shares, and fixed wealth equal to 10% of the stocks and options value (options are valued using Black-Scholes). The base-case exercise price is $30. Starting from the base case, the parameters are varied along two dimensions: First, the number of options is varied between zero and 600,000, and the number of stocks is adjusted to keep the portfolio value constant. Thus, each curve represents a different proportion of stocks and options. Second, the exercise price changes along each curve, and the number of stocks, options, and Tbills is adjusted proportionally to keep the portfolio value constant. Other parameters are: stock price = $40; asset volatility = 28%; asset beta = 0.7; market leverage = 15%; portfolio holding period = one year.

T-Bills, corresponds to 10% of the stock and option portfolio value. I discuss the sensitivity of the results to these assumptions below.[5]

Figure 1 reveals several striking results. First, options can substantially decrease managerial preference for risk and leverage for a wide range of exercise prices. In the figure, incentives are particularly strong and negative when options are in-the-money, between strike prices of $15 and $35 (the stock price is $40). Second, the example suggests that in-the-money options tend to discourage risk taking more than shares. For a portfolio consisting mostly of options, IC reaches -6.72% of certainty equivalent (-$0.66 million) at an exercise price of $23. This compares with IC of -1.19% (or -$0.15 million) when the CEO holds only shares of the same value. Third, the direction of the incentive effects is reversed for out-of-the-money options. In this region, replacing options with shares increases manager's preference for debt, although in this example the effect is comparatively

[5] I choose risk aversion of two as a starting point because this estimate is at the low end of the range of estimates in the literature. For example, Friend and Blume (1975) estimate risk aversion coefficients between two to three based on individual portfolio holdings. Mehra and Prescott (1985) cite a number of studies arguing that risk aversion

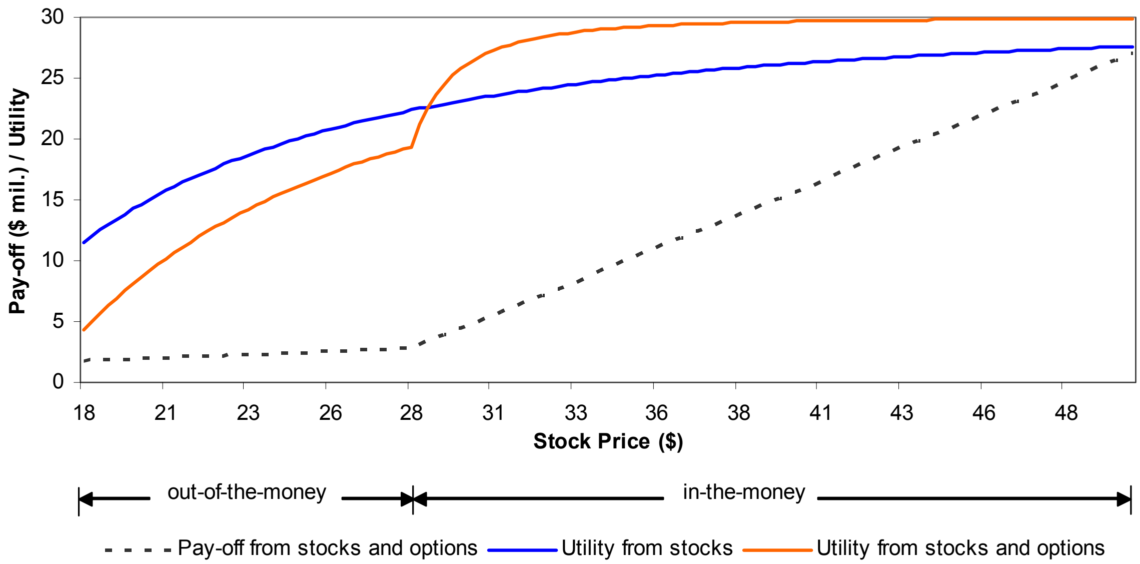


**Fig. 2: CRRA utility for a stock portfolio and a stock and option portfolio.** The stock and option portfolio consists of 1 mil. options (exercise price = $28) and 100,000 shares; the stock portfolio consists of 120,000 shares. The figure depicts the constant relative risk aversion (CRRA) utility for each portfolio as a function of the liquidation-time stock price. The figure also shows the payoff ($ mil.) from the stock and option portfolio. The assumed risk-aversion parameter is 3. The remaining parameters are the same as in Figure 1.

small. When the exercise price is $50, IC reaches 0.18% ($0.02 million) for the portfolio consisting mostly of options. Note that for the median CEO portfolio, financing incentives are negative, with IC equal to -1.88% (-$0.22 million).

Figure 2 provides intuition for these results and shows that the qualitative conclusions are fairly general. The figure compares utility derived from an all-stock portfolio and a portfolio consisting of options and shares. Utility is measured as a function of the end-of-period stock price, rather than wealth. The graph illustrates that option payoff causes a kink in the utility function. The function becomes convex in the region close to the kink. However, the option payoff also magnifies the *concavity* of the utility function in the area to the right of the kink, i.e., when the options are in-the-money. (Appendix 1 derives analytical expression for both convexity and concavity magnification effects, following the approach in Ross (2003)). This suggests that options could either decrease or increase CEO risk aversion: they make the utility function more convex in some region but more concave in another. Table 1 shows that when shares are replaced by options of the same value, the magnification effect dominates for the median CEO portfolio and for a wide range of risk-aversion and outside-wealth assumptions.

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is close to one. Most studies use estimates in the range of one to five (see, for example, Mehra and Prescott, Lambert

All examples in this section, including Figure 2, use power utility, and an obvious question is whether the basic conclusions are valid for alternative utility functions. Appendix 1 addresses this issue. Using an approach similar to Ross (2003), the appendix shows analytically how a given incentive contract affects agent's aversion to stock volatility. It shows that the magnification and convexity effects are general, and are not limited to power utility.[6] Moreover, the direction and magnitudes of these effects depend primarily on the shape of the payoff rather than on the shape of the utility function, as long as the utility function is concave. Consistent with this result, replicating Figure 1 assuming constant *absolute* risk aversion (CARA utility) has little effect on the shape of the curves (details are in the appendix).

Finally, the appendix points out that, in addition to the convexity and magnification effects shown in Figure 2, an incentive scheme can alter an agent's attitude towards risk simply because it makes him more (or less) wealthy. This effect depends on whether the agent's risk aversion is increasing or decreasing in wealth. It has little to do with the convexity of the contract (it can be induced by simply scaling a given payoff). The examples in this section hold the Black-Scholes value of the CEO's portfolio constant, so the wealth effect is small (all results are similar when the certainty equivalent is held constant instead). Moreover, with CRRA utility, the wealth effect is completely eliminated if we consider *relative* risk aversion as the measure of the agent's attitude towards risk. Nevertheless, we should keep in mind that the wealth effect could be important if we are interested in comparing contracts of different value to the executive.

#### *2.2.3 Risk aversion and outside wealth*

Most parameters in Figure 1 are close to their sample medians and are therefore representative of actual firms. However, two key variables, the CEO's risk aversion and outside wealth, are unobservable parameters. Figure 3 and Table 1 show estimates for a range of different assumptions. As an example, Figure 3 depicts incentives for the benchmark portfolio of 216,000 shares and 200,000 options. The amount of fixed wealth is varied from 10% to 100% of the stock and option portfolio value, and the assumed risk-aversion coefficients are two and three. (Table 1 considers a range of additional scenarios.)

The figure shows, not surprisingly, that higher fractions of T-Bills or lower risk-aversion coefficients lead to less negative incentive estimates for all considered portfolios. But importantly, all

et al. (1991), Campbell (1993), Carpenter (1998), Hall and Murphy (2002)).

[6] Ross (2003) and Appendix 1 assume, for simplicity, that the payoff is twice differentiable in the entire domain. This assumption is violated at the point when options are at-the-money, and, in this region, the results can be viewed only as an approximation (see Basak, Pavlova, and Shapiro (2002)).

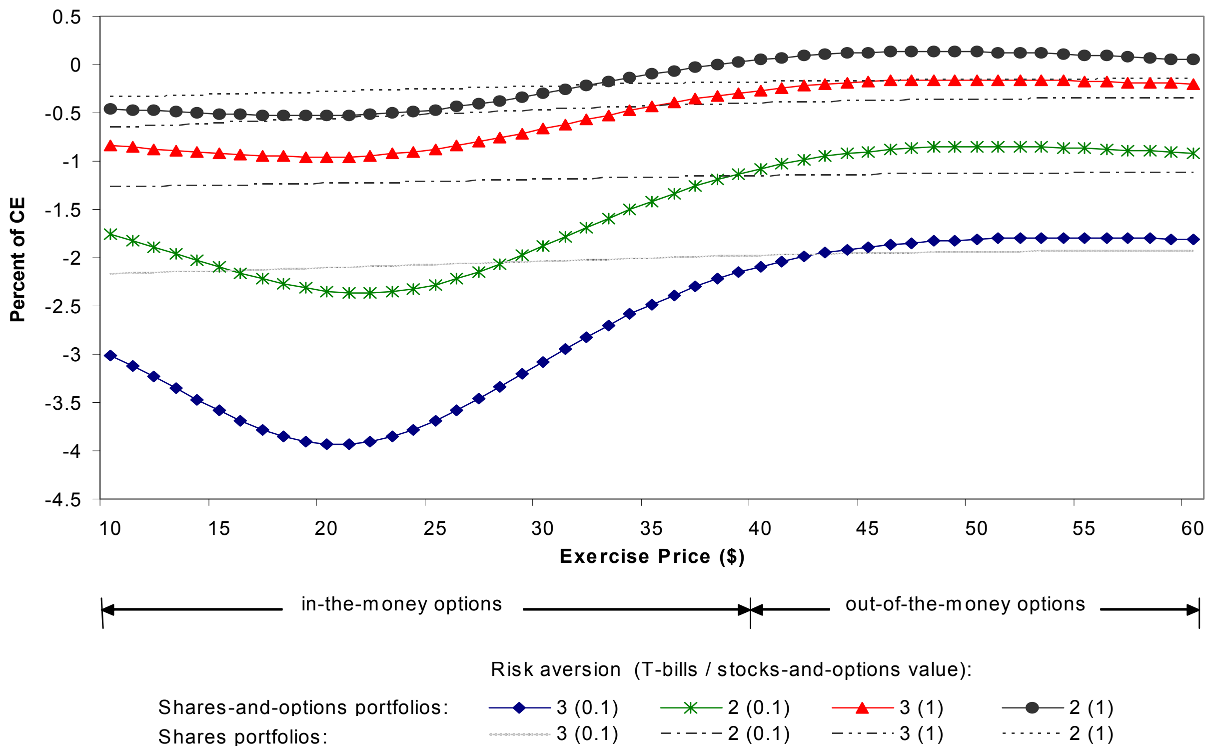


**Fig. 3: Financing incentives for different assumptions about risk-aversion and outside wealth**. Financing incentives are measured as the percentage change in certainty equivalent of CEO wealth caused by a 10 percentage points leverage increase. The CEO holds 200,000 options, 216,000 shares, and fixed wealth equal to 10% or 100% of the stocks and options value (options are valued using Black-Scholes). The CEO has a CRRA utility function with a risk-aversion parameter of 2 or 3. Other parameters are: stock price = $40; asset volatility = 28%; asset beta = 0.7; market leverage = 15%; portfolio holding period = one year. The dashed lines represent shares portfolios constructed as follows: for each stock and option portfolio depicted in the figure, I replace all options with shares of the same value while holding everything else constant.

curves in Figure 3 have the same shape and the basic patterns documented in Figure 1 are still present. First, financing incentives remain negative if options are sufficiently in-the-money. Second, similar to Figure 1, replacing in-the-money options with shares of the same value often makes the CEO *less averse* to risk and leverage. To illustrate this, for each portfolio depicted in Figure 3, I replace all options with shares of the same value. The dashed lines in Figure 3 show financing incentives created by these shares portfolios.

The analysis in Figure 3 suggests that empirical tests which rely on CE estimates of incentives could be sensitive to the assumptions about risk aversion and outside wealth. As a robustness check in the empirical part of the paper, I estimate financing incentives for a range of different risk-aversion and outside-wealth assumptions. I find that the estimates differ in magnitude but are highly positively correlated in the cross section (the correlations in Table 5 range from 87% to 98%). Consequently, the empirical tests are robust to the alternative assumptions about risk aversion and outside wealth.

### 2.2.4 Black-Scholes vs. certainty equivalent approach

The numerical results contradict the conventional wisdom that options increase managers' preference for risk and, consequently, leverage. Because this intuition frequently comes from standard option pricing results, it seems useful to compare the Black-Scholes and certainty-equivalent frameworks. Black-Scholes assumes that investors can trade freely; option value is independent of preferences either because investors are well-diversified or can dynamically replicate the option. These conditions are violated for most executives. A significant fraction of executives' wealth is tied to firm performance and executives are restricted in their ability to hedge their portfolios. Consequently the basic assumption underlying the Black-Scholes model are generally violated for executive stock options.

Black-Scholes and the CE approach make very different predictions about the magnitude and direction of leverage incentives. According to Black-Scholes, options always increase a manager's preference for risk and leverage – an increase in volatility simply increases the option's value – while the CE approach often predicts the opposite effect. Further, the two models make different predictions about how financing incentives vary across firm characteristics. For example, there is a positive relation between Black-Scholes incentives and volatility, but often a negative relation between CE incentives and volatility (see below). Similarly, according to Black-Scholes, CEOs with larger fractions of stock options in their portfolios are more willing to take risks. The relation is reversed for a wide range of assumption in the CE model. Consistent with these patterns, the correlation between Black-Scholes and CE incentives in my empirical sample is *negative* and close to zero. This suggests that Black-Scholes estimates provide a poor proxy for the actual risk incentives of undiversified executives.

### 2.2.5 Financing incentives and firm characteristics

The analysis above is based on the characteristics of the median sample firm. Figure 4 explores how financing incentives depend on asset volatility and market leverage. It focuses on a CEO with somewhat in-the-money options, similar to the median CEO (as before, different curves in each graph represent portfolios with different proportions of stocks and options). In this example, I assume a risk-aversion coefficient of two and Tbill ratio of 10%. The analysis suggest that financing incentives vary strongly with firm characteristics. The common pattern in all examples is that incentives decline with asset volatility and market leverage. The direction of these effects is robust

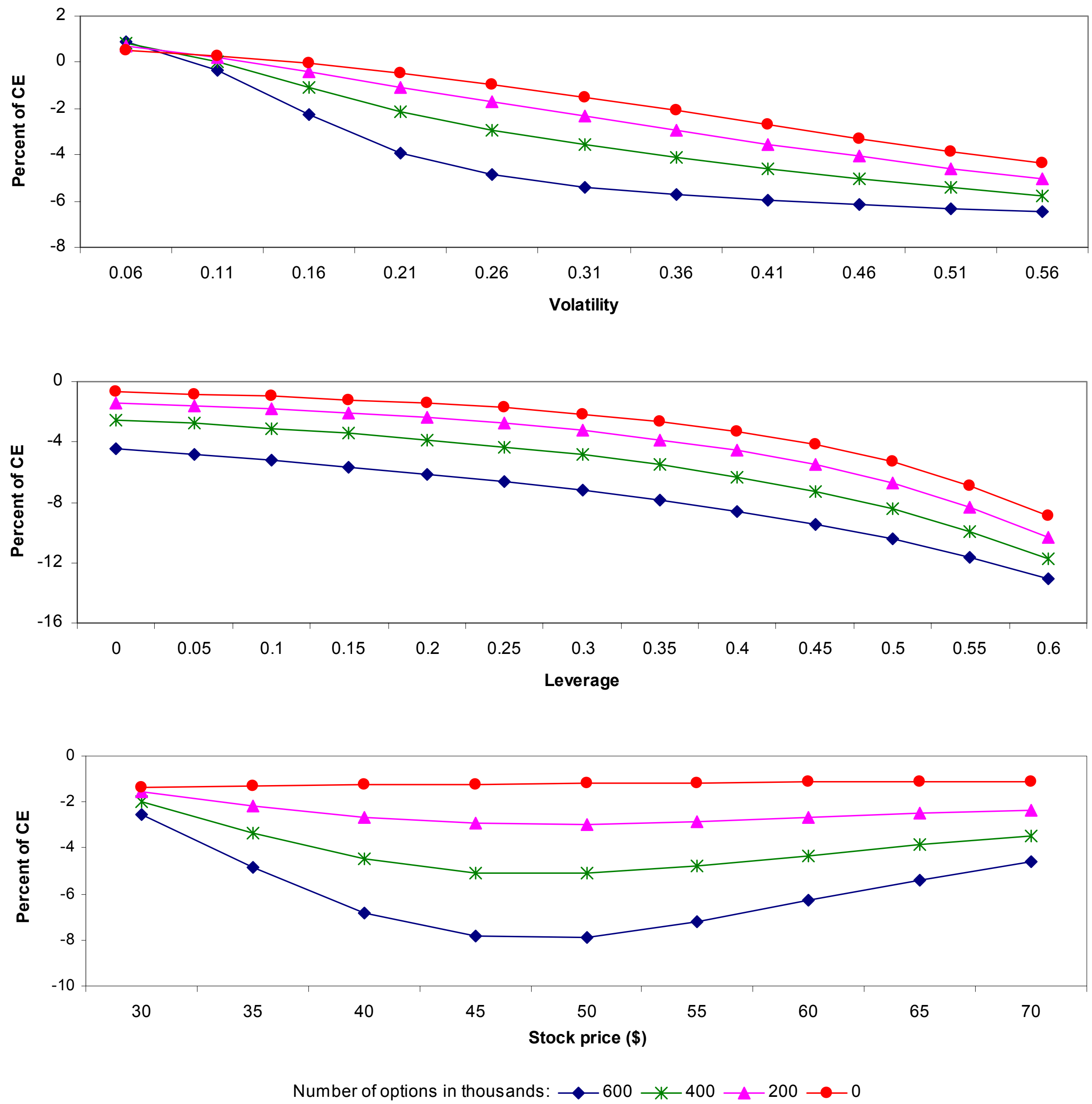


**Fig. 4: The effects of volatility, leverage, and stock price on financing incentives.** Financing incentives are measured as the percentage change in certainty equivalent of CEO wealth caused by a 10 percentage points leverage increase. The CEO has a CRRA utility function with a risk-aversion parameter of 2. The parameters for the base case are: exercise price = $30; stock price = $40; asset volatility = 28%; asset beta = 0.7; market leverage = 15%; portfolio holding period = one year; CEO's portfolio = 200,000 options, 216,000 shares, and fixed wealth equal to 10% of the stocks and options market value. In each figure, starting from the base case, the number of options is varied between 600,000 and zero, and the number of stocks is adjusted to keep the market value of the portfolio constant. Thus, each curve represents a different proportion of stocks and options. In the first two figures, volatility (leverage) is varied along each curve, and the number of stocks, options, and T-bills is adjusted proportionally to keep the portfolio market value constant. In the last figure, stock price is varied along each curve holding the CEO portfolio fixed; leverage, stock volatility, and beta change with the stock price.

to the considered risk-aversion and outside-wealth assumptions (results for alternative assumptions are not reported). This is consistent with the result in Table 5 that incentives estimated under different assumptions are highly correlated.

The first two panels of Figure 4 essentially ask how incentives vary across firms. Alternatively, one could ask how incentives change for a *given firm* in response to changes in business conditions. To illustrate this idea, the last panel shows how financing incentives react to a change in stock price. The CEO's portfolio is fixed, so CEO wealth increases as the stock price goes up; at the same time, leverage and stock volatility decline. Interestingly, a price increase might substantially reduce the CEO's preference for debt as options become somewhat in-the-money. For example, if the CEO has 600,000 options, IC drops from roughly –2% if the stock price is $30 (at-the-money options) to –8% if the stock price increases to $45. In contrast, static-tradeoff theory predicts that shareholders will prefer more debt is firm value goes up, because an increase in value tends to reduce the agency costs of debt and the probability of financial distress. Therefore, this example suggests that stock price changes may induce, at least temporarily, a divergence between stockholders' and managers' incentives to raise debt.

The key results from the numerical analysis are as follows. (1) Contrary to conventional wisdom, stock options often discourage managerial risk taking and leverage. (2) The *magnitudes* of financing incentives created by options depend on the assumptions about risk aversion and outside wealth, but *the variation* in incentives across firms and CEO portfolios is fairly robust to these assumptions; incentives estimated under different outside-wealth and risk-aversion assumptions are highly correlated. (3) Black-Scholes and CE approaches to analyze risk incentives differ substantially. They disagree not only about the direction and magnitudes of incentives, but also about how incentives vary across firms. Empirically, the correlation between Black-Scholes and CE incentives is *negative* and close to zero.

## 3 Hypotheses

Section 2 shows that stock-based compensation can make debt financing costly to executives. These volatility costs create an incentive for managers to push leverage below the level preferred by shareholders. In principle, disciplinary forces inside and outside corporations should counteract these incentives, so the null hypothesis for the empirical tests is that there is no association between financing decisions and managers' private costs of debt. But, as explained in this section, compensation costs, contracting costs, and imperfect monitoring suggest that manager's incentives might influence financing decisions.

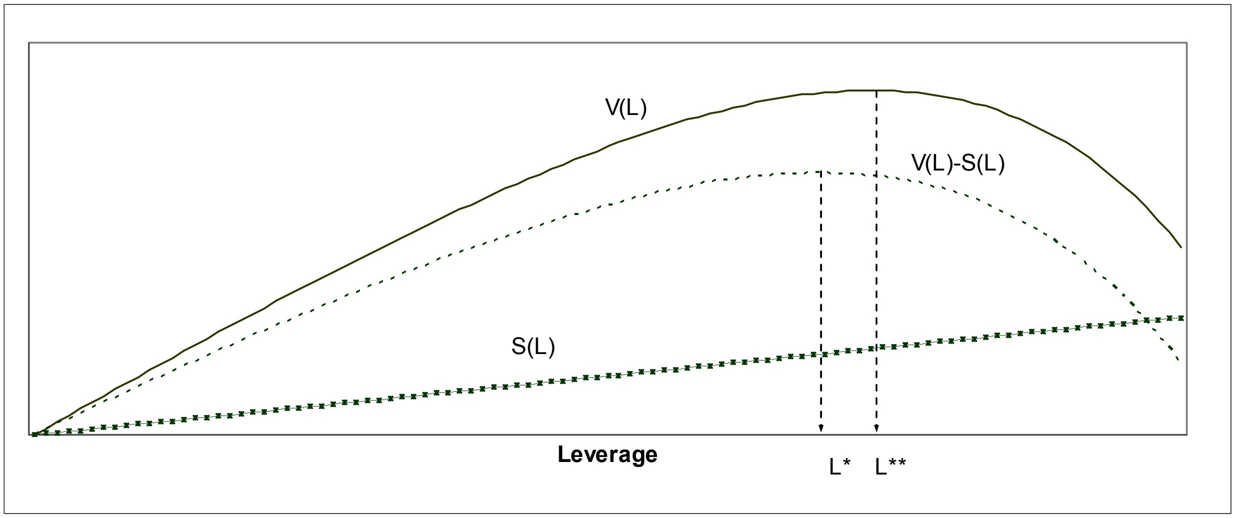


**Fig. 5: The effect of manager's private costs of debt on shareholders' choice of leverage.** V(L) is the value of the firm including manager's salary as a function of leverage. S(L) is the minimum pay that the manager requires for any given leverage level.

## 3.1 Compensation costs

Suppose, first, that shareholders have perfect knowledge of financing policy and do not delegate financing decisions do management. Shareholders choose leverage by trading off the costs and benefits of debt, including interest tax shields, expected bankruptcy costs, and underinvestment problems. Suppose also that the leverage choice has no impact on managers' welfare. Figure 5 depicts an example of a function that maps leverage, L, to firm value, V(L), assuming that V(L) is strictly concave and has an interior maximum at L**.

Now introduce manager's private costs of debt. Since an important source of these costs is incentive compensation, the model should, ideally, solve simultaneously for the optimal incentive contract and the optimal capital structure. Such a model is clearly beyond the scope of this paper. Instead, to illustrate the basic point, I assume that the manager's stock and option portfolio is fixed and the only problem faced by shareholders is to determine the amount of fixed salary, S, and leverage, L. (Section 5.4 discusses the simultaneous choice of compensation and leverage when this assumption is relaxed.)

Suppose that the manager requires a certain level of utility $\overline{U}$ to remain in the firm. Clearly, if shareholders maximize firm value, they will pay the manager just enough to satisfy this constraint. The function S(L) in Figure 5 depicts the minimum pay that the manager requires for any given leverage level. I assume that the function S(L) is upward sloping, which reflects the manager's net private costs of debt. It is easy to see that these private costs affect shareholders' choice of debt.

Shareholders face a new leverage-value function, V(L)′ = V(L) – S(L), and the new optimal leverage L* lies below L**. Thus, because managers dislike leverage, shareholders choose lower debt than they would in the absence of managers' costs. Moreover, the deviation of L* from L** is increasing in the marginal costs of leverage to executives (i.e., the slope of S(L)). This argument provides a link to the empirical tests in Section 5 because it suggests that managers' private costs of debt could help explain capital structure.

The example in Figure 5 assumes that shareholders control leverage. This may not be a good assumption if shareholders (boards of directors) are not sufficiently informed and prefer to rely on executives' expertise. To explore this possibility, consider a somewhat extreme case in which shareholders have no information about the function V(L) and managers are in charge of financing policy. If shareholders observe the actual leverage, they can write a contract that completely aligns managers' incentives with their own: shareholders pay the manager S(L) and, by doing so, fully compensate the manager for his private costs of debt. It is easy to see that this way, shareholders achieve the same outcome as if they fully controlled the capital structure. Since the contract makes the manager indifferent to leverage, he chooses leverage that maximizes firm value (L*). Thus, even in this case, it is still optimal for the firm to adjust leverage in response to shifts in the manager's private costs of debt.

### 3.2 Contracting costs

The example above illustrates why contracts like S(L), which compensate managers for their private costs of debt, may be difficult to implement. The solution works only under the assumption that shareholders know the function S(L). But S(L) depends on managerial preferences, so it is not known to shareholders (and might be complex). Under this condition, 'no contract' may be better than an 'imperfect contract'. This could be true, for example, if over-leverage is more costly to shareholders than under-leverage. Also, tying managerial wealth to leverage could result in various other distortions. For example, if leverage is defined using the market value of equity, then leverage is negatively related to stock price. An 'imperfect' leverage-dependent incentive scheme could then create an incentive to *decrease* stock price. Another question is how should leverage be defined: should it include long-term debt, short-term debt, trade credit, or should debt be expressed net of current assets? Any of these definitions might create inadvertent distortions. In short, it seems difficult to write contracts that perfectly align managers' and shareholders' financing incentives.[7]

[7] This may be one reason we do not observe contracts that tie managerial welfare directly to leverage. If these contracts were feasible, they could solve not only the managerial under-diversification problem, but also Jensen's

Consequently, leverage may temporarily deviate from its value-maximizing level in response to changes in managerial incentives.

### 3.3 Failure of the board

The discussion in Sections 3.1 and 3.2 assumes that contracting arrangements are efficient: leverage decisions maximize shareholder value net of contracting costs. Generally, it seems treacherous to argue that firms could persistently depart from this efficient contracting model, given the disciplining role of the capital markets, labor markets, and the market for corporate control (Fama (1980)). Nonetheless, many authors suggest, explicitly or implicitly, that firms' decisions are often inefficient. A prominent example is Jensen and Murphy (1990), who argue that the pay-for-performance incentives are too low.

The same view can be applied to the agency conflicts related to fincancing decisions. For example, the discussion above assumes that shareholders contract directly with management. In reality, shareholders are represented by the board of directors. Board members may, like managers, dislike leverage because their wealth and human capital are tied to the stock price or because they bear higher bankruptcy costs than other shareholders. Consequently, the board may not be sufficiently motivated to restrain managers' inefficient choice of debt (either through contracting or direct monitoring). There is also the possibility that the costs of debt resulting from option ownership are not perfectly understood by the shareholders or by the boards.

## 4 Data, sample selection, and descriptive statistics

I now turn to the empirical results. I estimate financing incentives for a large sample of U.S. firms and test whether incentives help explain actual financing choices. This section describes the sample and the key variables used in the analysis.

### 4.1 Data

The data on CEO stock and option ownership come from Standard & Poor's Execucomp database. I also use accounting data from Compustat, stock price data from CRSP, and marginal tax rate estimates provided by John Graham (http://www.duke.edu/~jgraham).

The Execucomp database covers 2,502 large U.S. firms from 1992 through 2001. The SEC has required detailed disclosure on executive compensation for fiscal years ending after December 15,

free-cashflow problem. Perhaps for similar reasons, firms do not pay managers extra for dividend payouts or for reduced cash balances if one thinks that managers have incentives to overinvest.

1992, and the Execucomp database is virtually complete for years 1993 through 2001. The database contains the number of shares, restricted shares, and options owned each year for each executive. It also has detailed information on option grants in the current year, including the number of options granted, the exercise price, and the expiration date as reported in the proxy statements. The database does not, however, include exercise prices and expiration dates for options carried over from prior years. It is impossible to infer this information precisely because firms do not disclose which options have been exercised (we know the number of exercised options, but not their strike prices if the CEO has several sets of options). I approximate exercise prices and expiration dates using an algorithm suggested by Guay (1999) and Core and Guay (1999), which relies on detailed information about current and past option grants. I assume that the CEO always exercises the 'oldest' grants first. Therefore, his portfolio in any given year consists of the grants awarded in the recent years. These grants are described in detail in past proxy statements, so the information is available from previous years' observations on Execucomp.

Because Execucomp starts in 1992, the procedure does not allow me to identify the exercise prices of *all* stock options held by each CEO in any given year. Suppose, for example, that a CEO holds 500 options in year 1998, and 450 options were granted in between 1992 and 1998. To approximate the exercise prices of the remaining 50 options, I use proxy-statement information on the 'realizable value' of unexercisable options held in year 1992. Realizable value, provided separately for exercisable and unexercisable options, is the total profit that the executive could obtain if all options are exercised at the end of the fiscal year. The average exercise price of unexercisable options in a given fiscal year is approximated as: (closing price for the fiscal year – realizable value of unexercisable options) / number of unexercisable options. This measure tends to overestimate the true average exercise prices because out-of-the-money options have realizable values of zero, regardless of the extent to which they are out-of-the-money.

### 4.2 Sample selection

The sample construction is described in detail in Table 2. The initial sample consists of 2,502 firms and 13,580 firm-year observations from 1993 through 2001. In this sample, 256 observations have missing compensation or ownership data. In addition, there is time inconsistency in the reporting of option holdings and option grants: holdings are usually reported as of the end of the fiscal year, but some companies report their option grants for a slightly longer period, including a few months between the end of the fiscal year and the proxy statement date. This problem can sometimes lead to large errors in the estimates of exercise prices. I delete observations for which option grants appear to be inconsistent with reported option holdings (1,416 observations).[8]

The computation of incentives requires estimates of stock volatility, market beta, and financial leverage. Merging with CRSP and Compustat reduces the sample to 2,305 firms and 11,138 observations. From this sample, I exclude 336 financial firms and 146 utilities. I also drop 157 observations with negative book equity, 22 observations when the CEO has no stock or options, and 18 observations with market leverage higher than 90%.[9] The final sample, with data available for all control variables described later, consists of 1,587 firms (7,255 observations) for the debt-level regressions and 1,504 firms (6,333 observations) for the debt-change regressions. The sample for leverage changes is smaller because each observation requires three fiscal years of data. The sample of firms used for the probit model is described later.

### 4.3 Descriptive statistics

Descriptive statistics for the sample are presented in Table 3 and a correlation matrix for the variables is in Table 4. Appendix 4 contains the variable definitions. The sample represents about 14% of all non-financial non-utility firms on Compustat during the 1993 – 2001 period. The average firm is large, with book value of assets equal to $3.9 billion (median, $0.9 billion) and market value equal to $8.3 billion (median, $1.6 billion). For comparison, the average non-financial, non-utility firm on Compustat has book assets of $1.6 billion (median of $86 million) and market value of $2.8 billion (median of $155 million).

I use several proxies for growth options: the market-to-book ratio; R&D expense in percent of total assets; and property, plant, and equipment plus inventories in percent of total assets. The means of all three measures suggest that the sample firms have fewer growth options than the average Compustat firm. For example, the average M/B ratio for the sample is 4.8 compared with a mean of 6.4 for Compustat firms. However, the median M/B ratio is larger for the sample (2.5) than for the population (2.1). Also, capital structure is similar for the sample and population. For example, the mean book leverage for the sample is 32% (median is 32%) compared to 31% (median of 27%) for the average Compustat firm.

The bottom part of Table 2 describes CEO wealth and wealth composition. The average CEO

[8] Specifically, I check whether the number of options owned in a given year equals the number from the previous year plus option grants and minus options exercised in the current year. I set the incentive estimates to missing for years in which this relation is violated by more than 50,000 options. I also delete the observations for which the estimated exercise price is negative.

[9] The reason for this last condition is that incentive effects associated with a 10 percentage point leverage increase are not defined for the high-levered firms.

owns 3.5% of his company's common stock (the median is 0.5%). In most cases, CEO ownership is relatively small (for example the third quartile is only 2.6%), but it exceeds 37% for one percent of the sample. Option holdings, measured in percent of shares outstanding, are also positively skewed with a mean of 1.1%, median of 0.6%, and 99$^{th}$ percentile of approximately 7%. The market value of the stock and option portfolio (options are valued here using Black-Scholes) for the median CEO is about $13 million (the mean is $114 million). The sample includes CEOs like Bill Gates in 1999 or Michael Dell in 1998 with total wealth of $70 billion and $19 billion, respectively. On average, options constitute about 37% of the CEO portfolio value (median is 31%).

### 4.4 Financing incentives – descriptive evidence

Table 5 reports descriptive statistics for financing incentives. The estimates are constructed in the same way as the example in Section 2 (see especially Section 2.1). Financing incentives measure the volatility costs associated with a leverage increase of 10 percentage points.[10] Table 5 reveals considerable variation in the volatility costs across firms. For example, for risk aversion of three and outside wealth of 10%, the incentives range from –22.45% (1st percentile) to –0.40% (99$^{th}$ percentile), and the mean is -5.12%. Interestingly, the estimates are *negative* for most CEOs in my sample, even assuming outside wealth of 100% and risk aversion of two. The correlation matrix in Table 4 shows that volatility costs are higher for firms with higher stock return volatility, higher leverage, as well as for CEOs with more stock options. These patterns are consistent with the numerical analysis in Section 2.

Also, the *magnitude* of volatility costs depends on the assumptions about risk aversion and outside wealth, but their *cross-sectional variation* is robust. For example, for risk aversion of three, the mean estimates vary from -5.12% to -1.04% as T-Bills change from 10% to 100% of stock and option value. However, the incentives computed under different risk-aversion and outside-wealth assumptions are highly correlated, with correlations in Table 5 ranging from 87% to 98%. Because the correlations are so high, the empirical tests in Section 5 are robust to different assumptions about risk aversion and outside wealth. To save space, I present only results based on the risk aversion of three and outside wealth of 10%.

[10] I also compute incentives associated with a marginal leverage increase of one percentage point. These marginal incentives are highly correlated with the estimates in Table 5 (correlation of about 99%) and their means, medians etc. are approximately one-tenth the corresponding statistics in Table 5.

# 5 Do managerial incentives affect financing policy?

The descriptive evidence shows that financing decisions can have a large impact on CEOs' utility. In this section, I test whether managerial incentives affect actual financing choices using three different approaches: I first estimate a model of debt-equity choice and then explore cross-sectional variation in debt levels and debt changes.

## 5.1 Debt-equity choice

The first set of tests are based on a probit model of debt-equity choice, similar to those in Marsh (1982), MacKie-Mason (1990), Hovakimian, Opler, and Titman (2002), and Jung, Kim, and Stulz (1996). In particular, I test whether, conditional on a decision to raise outside funds, managers with stronger incentives to increase leverage (i.e., those with lower volatility costs of debt) are more likely to issue debt than equity.

Focusing on firms' decisions to *change* leverage, instead of debt levels, has several advantages (MacKie-Mason, 1990; Graham, 1996; Berger, Ofek, and Yermack, 1997; Jung, Kim, and Stulz, 1996). First, debt levels are a result of years of financing decisions. Thus, unless we can control for important determinants of these past decisions, level regressions may have both power and omitted variables problems. Empirically, for example, there is little support for tax-based theories of financial structure using level regressions, but debt-equity choice models provide such support. Finally, the residuals in a leverage change or debt-equity choice model should be close to serially uncorrelated (see Fama and French, 2002). Since the Fama-MacBeth methodology eliminates cross-correlation problems, I can reliably test the statistical significance of the regression coefficients using Fama-MacBeth t-statistics.

### *5.1.1 Model of debt-equity choice*

Models of debt-equity choice focus on firms that raise outside capital to finance investment. They predict, based on the static-tradeoff theory, that the decision to issue debt vs. equity should be determined by the deviation of current leverage from its long-term target, as well as the tax benefits and expected bankruptcy costs associated with additional debt. In addition, several studies (e.g., Asquith and Mullins, 1986; Mikkelson and Partch, 1986; Jung, Kim, and Stulz, 1996; Hovakimian, Opler, and Titman, 2000) find that firms are more likely to issue equity rather than debt after a stock price increase. In this section, I extend these models to test whether volatility costs of debt have an incremental effect on the executive's issue decision. In particular, I estimate a probit model of debt-equity choice with financing incentives (IC) as an explanatory variable. The control variables include the current leverage ratio and a proxy for leverage target, estimated each year as a fitted value from a cross-sectional leverage regression (see the definition in Appendix 4). Altman's (1968) z-score and stock return volatility proxy for bankruptcy probability. The return on assets and Graham's (1996) marginal tax rate measure the potential tax benefits of debt. Similar to previous studies, I include the issue size, the market-to-book ratio and the stock return measured over the preceding fiscal year. In addition, I control for factors that, based on the analysis in Section 2, are associated with financing incentives (i.e., CEO stock and option ownership and stock return volatility) to test whether any of these variables drives the coefficient on IC. The independent variables are for the fiscal year preceding the debt or equity issue.

### *5.1.2 Sample of debt or equity issuers*

The sample consists of firms that raise a significant amount of new capital. A firm is classified as a debt issuer in a given fiscal year if its net debt issue in that year (i.e., debt issued minus debt retired) exceeds 1% of total assets. Similarly, an equity issuer is a firm with a net equity issue (i.e., equity issued minus equity repurchased) higher than 1% of total assets. The results are similar when the cut-offs are 2% or 3%. The sample consists of 1,900 firm-years (890 firms) classified as debt issuers and 957 firm-years (593 firms) classified as equity issuers over the period from 1993 through 2001 (companies that issue both debt and equity in excess of 1% of total assets are excluded from the sample). Descriptive statistics for both samples are in Table 3. Firms that issue equity are significantly smaller, more volatile, and less levered than firms that issue debt. They also tend to experience higher stock returns in the year preceding the issue. The CEOs of equity issuers have higher stakes in their firms than the CEOs of debt issuers. The univariate analysis also suggests that equity issuers have significantly higher volatility costs of debt. On average, a hypothetical 10% leverage increase causes a wealth decline of 5.8 percentage points for an equity issuer's CEO and a wealth decline of 4.6 percentage points for a debt issuer's CEO.

### *5.1.3 Results*

The probit model is reported in Table 6.  The results support the hypothesis that managerial incentives affect firms' financing decisions. The coefficients on incentives are positive and highly significant in all specifications: the panel t-statistics range from 4.6 to 8.7. To account for potential cross-correlation problems, I also estimate the probit model separately for each of the nine years in the sample, and compute Fama-MacBeth (1973) t-statistics from the yearly coefficients. The t-statistics, ranging from 3.4 to 5.4, confirm statistical significance at a 1% level in all regressions. The impact of volatility costs on the issue choice seems economically significant. Increasing the volatility costs by one standard deviation decreases the probability of a debt issue by 8.6 to 4.3 percentage points, depending on specification.

Although stock and option ownership per se is not the focus of the paper (other than as a determinant of volatility costs), it is interesting to note that option ownership is positively related to the probability of a debt issue, although the coefficient is significant in just one of the three regressions. The positive coefficient is consistent with the findings of Mehran (1992) and Berger, Ofek, and Yermack (1997). One of the interpretations offered in the literature is that options induce risk-taking incentives and create preference for higher leverage. This interpretation is inconsistent with the CE approach, which shows that options often discourage, rather than encourage, the use of debt. Option ownership is actually *negatively* correlated with financing incentives (the correlation coefficient in Table 4 is -17%).

The coefficients on the control variables are generally consistent with capital structure theories and similar to previous studies. However, contrary to the tradeoff predictions, I find that firms with higher leverage tend to finance their investment with debt rather than equity, even after controlling for leverage targets. Consistent with this result, the coefficient on the deviation of current leverage from the target is not statistically significant (this result is not reported). Although the results in my paper could be interpreted as evidence against tradeoff theory, it is possible that the target estimates do not fully capture the actual leverage targets. As alternatives, I replace the 'fitted-values' target estimates by simple industry averages. I also experiment with different explanatory variables in the target regression. Finally, in the last column in Table 6, I include the explanatory variables from the target regression individually instead of the target estimate itself (similar to MacKie-Mason (1990) and Kim et al. (1996)). None of these changes significantly affects the coefficient on the target or on incentives.

### 5.2 Debt-change model

As a second test of the 'volatility costs' hypothesis, I test whether shocks to financing incentives are associated with subsequent changes in debt. As a framework for the tests, I use a debt-change model that nests static trade-off and pecking-order theories (similar to Fama and French, 2002). In this model, leverage has a tendency to revert to its long-term target but short-term variation in debt is determined by pecking-order behavior: to minimize transaction and asymmetric-information costs, firms finance their investments first with retained earnings, then with debt, and finally with equity. The model predicts that short-term changes in debt should be related to changes in current or expected profitability and in current or expected investment opportunities. In addition, the deviation of current leverage from its long-term target should affect the changes in debt.

Within this framework, I test whether managers' volatility costs have an incremental impact on financing decisions. Volatility costs change over time with fluctuations in debt, firm value, stock volatility, or executive ownership. As these costs go up, they may create a stronger tendency for managers to reduce debt. Similarly, a decline in volatility costs could make a leverage increase more likely. To test this hypothesis, I regress debt changes scaled by lagged total assets on lagged changes in incentives (the results are similar when incentives levels are used instead). I also include control variables suggested by the tradeoff and pecking-order theories. Following Fama and French (2002), I use changes in net income to control for the short-term fluctuation in profitability, and changes in assets to control for time-variation in investment. As in the previous section, target leverage is computed each year as fitted values from the leverage level regression (the target regression is described in Appendix 4). Finally, I include changes in shares and option ownership and changes or levels in stock return volatility, i.e., factors that enter the computation of incentives, as additional control variables.

*5.2.1 Results*

Table 7 documents a positive and significant association between incentive changes (ΔIC) and subsequent changes in leverage. The panel t-statistics for the coefficients on ΔIC range from 2.33 and 2.91, and Fama-MacBeth t-statistic computed from nine yearly coefficients are between 1.82 and 1.97. Thus, the regressions suggest that executives experiencing an upward (downward) shift in volatility costs of debt are less (more) likely to finance future investment with debt. Interestingly, changes in stock and option ownership, that are directly responsible for shifts in incentives, are themselves not associated with subsequent financing decisions. The coefficients on the control variables are consistent with Fama and French (2002).

Although the change regressions support the hypothesis that volatility costs affect financing decisions, the regressions seem less robust than the probit model or the leverage-level regressions described in the next section. First, the results vary somewhat depending on the choice of the dependent variable. Although the coefficient on ΔIC is positive and significant when the dependent variable is change in total debt, change in long-term debt, or change in market leverage, it is not significant when the dependent variable is change in book leverage (only regressions with change in total debt are reported). Second, the dependent variables are considerably skewed, and I use log specifications in the reported regressions. The results tend to be somewhat weaker when the dependent variable is a raw change in debt (or change in leverage). As another robustness test, I rank the debt-changes and use the ranks as the dependent variable. The statistical significance is highest using these rank regressions (the robustness tests are not reported). Finally, Appendix 2 presents an alternative model to estimate financing incentives that assumes that equity is a call option on firm's assets. When this alternative model is used, the coefficient on ΔIC in the change regressions is no longer significant, whereas the results in the probit model and level regressions are robust to the way incentives are estimated. In sum, change regressions provide additional evidence in favor of the 'volatility costs' hypothesis, although the evidence is somewhat weaker than in the probit model or leverage-level regression described next.

## 5.3 Level regressions

Static-tradeoff theory predicts that firms choose debt levels to manage the interaction among taxes, bankruptcy costs, and agency conflicts. Here, I test whether managers' financing incentives are also important. I first describe the basic OLS regressions and then discuss the endogeneity of compensation and leverage.

### *5.3.1 Measuring incentives for the levels regressions*

The tests regress leverage on an estimate of the volatility cost of debt. Volatility costs estimated at the *actual* leverage level (IC) are not appropriate for these regressions because leverage and IC are simultaneously determined. For example, an increase in leverage tends to decrease IC through its impact on stock volatility, as shown in Section 2, and a positive shock to IC (e.g., caused by a volatility increase) creates an incentive for management to lower debt. To avoid these problems, I slightly modify the measure of incentives: I compute the volatility costs that the manager would face if the firm had no debt, measured as the change in CE caused by an increase in leverage from 0% to 10%. This quantity, denoted $IC^0$, captures the volatility costs of debt independent of actual leverage (the computation of $IC^0$ is similar to $IC^1$, except that the stock's standard deviation and beta are unlevered). In principle, it would be best to take into account how costs change as leverage increases, rather than just use marginal volatility costs at zero leverage. As a robust-ness check, I estimate volatility costs at the median leverage and at the first leverage quartile. The regression coefficients are insensitive to these assumptions, and I present only regressions with incentives estimated at zero leverage.

### *5.3.2 Other determinants of leverage*

The regressions include a number of control variables that proxy for previously identified determinants of debt. The M/B ratio, PP&E, and R&D expense proxy for investment opportunities and intangible assets. Depreciation expense and Graham's (1996, 1996b, 2000) marginal tax rates (before interest) control for non-debt tax shields. Earnings volatility and firm size proxy for expected bankruptcy costs, although I drop earnings volatility from the reported regressions because it substantially reduces the sample size but has no significant effect on the results. Asset uniqueness is measured by advertising expenditures in percent of sales. I include 48 Fama and French (1997) industry dummies to control for industry effects. In addition, I include Herfindahl index to control for industry concentration. Finally, I include a dummy variable equal to one if a firm pays dividends. Variables that enter the computation of $IC^0$ (asset volatility and beta, and stock and option ownership) are included to test if any of them individually drives the association between leverage and incentives. Appendix 4 describes all control variables in more detail.

### *5.3.3 Results*

The results for the market-leverage and book-leverage regressions are reported in Table 8. In principle, market leverage seems most appropriate to test the importance of volatility costs of debt because market leverage affects equity risk. I include book-leverage regressions as a robustness check. The coefficients on financing incentives have the predicted positive sign in all specifications. The panel t-statistics on $IC^0$ vary from 12.5 to 29.1 for market leverage and from 4.4 to 17.7 for book leverage as the dependent variable. A one-standard-deviation increase in volatility costs ($IC^0$) is associated with a market-leverage (book-leverage) decline in the range of 6.0 to 2.5 (4.5 and 1.2) percentage points, depending on specification. This evidence suggests that volatility costs help explain the differences in leverage ratios across firms.

The t-statistics from the panel regressions in Table 8 are probably overstated because the residuals are correlated both across time and across firms. To account for these problems, I estimate modified Fama-MacBeth t-statistics from yearly regressions assuming that the yearly coefficient estimates on incentives follow an AR1 process. These tests confirm the statistical significance of financing incentives. For example, the 'ordinary' Fama-MacBeth t-statistics, which assume zero autocorrelation, are 5.5 in the market regression and 4.5 in the book regression when all control variables in Table 8 are included. The coefficients remain significant for high assumed autocorrelations of up to 80% percent.

Consistent with the evidence from the probit model, leverage is higher for firms with a higher CEO option ownership and a lower CEO share ownership but the inclusion of these variables has little impact on the coefficient on $IC^0$. The coefficients on the remaining control variables are generally consistent with previous studies, except for the positive association between the book leverage and market-to-book ratio. The coefficient on Graham's marginal tax rate has the opposite sign predicted by the tradeoff theory. This suggests that the variable proxies for profitability and, consistent with the pecking-order theory, the firm's need for outside capital. Including ROA in the leverage regressions supports this hypothesis (the coefficient on marginal tax rate becomes insignificant).

Consistent with prior studies, I find that leverage is positively associated with option ownership and negatively associated with share ownership (see, for example, Mehran (1992) and Berger et al. (1997)). There are several possible explanations for these relations. For example, Berger et al. (1997) suggest that higher option ownership indicates less entrenched management because more effective boards of directors are more likely to award performance-based executive compensation. If more entrenched managers choose lower leverage (e.g., to avoid performance pressures associated with commitments to pay out cash (Jensen (1986)), we might observe a positive relation between option ownership and debt. Another explanation is that performance-based compensation and leverage are employed as alternative means to control agency conflicts between managers and shareholders. This endogenous relation could be responsible for the significant coefficients on shares and option ownership, and I discuss the endogeneity issues in more detail in Section 5.4.

### 5.4 Endogeneity of financing incentives, ownership, and leverage

A problem faced by many corporate finance studies is that almost any variable of interest might be endogenous. The most obvious source for endogeneity problems here is that executive ownership and leverage are simultaneously determined. Since ownership enters the computation of incentives, the coefficient on incentives could be biased. I try to deal with this endogeneity problem in two ways. First, I model leverage and incentives in a system of simultaneous equations. Second, and perhaps more importantly, I show that the findings are robust using three different specifications: the level regressions, the change regressions, and the probit model of debt-equity choice. The latter two models are probably less susceptible to endogeneity problems than the level regressions.

Consider the level regressions in Section 5.3. There are several reasons to treat executive ownership and leverage levels as endogenous. For example, both debt and ownership could be employed as alternative means to limit free-cashflow problems. Jensen (1986) and Stulz (1990) suggest that managers have an incentive to spend excess cash on negative NPV investments. Debt disciplines executives by forcing them to pay out excess cash. Garvey (1997) extends this literature by examining leverage and compensation contracts as substitutes in dealing with the free-cashflow problem. Other theories suggest that leverage and ownership are endogenous because of voting rights and control issues (Stulz, 1988; Harris and Raviv, 1988; Zwiebel, 1994).

To help understand these issues, consider the following model describing the possible interdependence of financing incentives, executive ownership, and leverage:

$$LEV = \alpha_0 + \alpha_1 IC + \alpha_2 OWN + \alpha_3 Y_L + \varepsilon_L \tag{6}$$

$$IC = \beta_0 + \beta_1 OWN + \beta_2 Y_I + \varepsilon_I \tag{7}$$

$$OWN = \gamma_0 + \gamma_1 LEV + \gamma_2 Y_O + \varepsilon_O \tag{8}$$

LEV denotes leverage, IC is the volatility cost of debt, OWN is the executive ownership, and $Y_L$, $Y_I$, $Y_O$ denote other determinants of leverage, volatility costs, and ownership, respectively. Eqs. (6) and (8) reflect the simultaneous determination of executive ownership and leverage, as suggested by Jensen (1986), Stulz (1988), and others. Eq. (7) shows that ownership is one of the factors that determines financing incentives. Therefore, IC is also endogenous: it is easy to see that IC will be correlated with the residual in eq. (6).

In this model, a key assumption is that the endogeneity of IC is caused entirely by its correlation with OWN. As a consequence, if eq. (6) is estimated by OLS, the coefficient on OWN absorbs the endogeneity bias and *the coefficient on IC is unbiased*. One can see this by decomposing the residual in eq. (6) into a component that is correlated with ownership, $\delta$OWN, and an orthogonal component, $\varepsilon'$. Substituting $\varepsilon_L = \delta OWN + \varepsilon'$ into eq. (6) yields:

$$LEV = \alpha_0 + \alpha_1 IC + (\alpha_2 + \delta) OWN + \alpha_3 Y_L + \varepsilon' \tag{9}$$

Since $\varepsilon'$ is, by construction, uncorrelated with OWN and IC, eq. (9) satisfies the standard OLS assumptions. This implies that the estimate of $\alpha_1$ from eq. (9) (or equivalently from eq. (6)) will be unbiased.[11]

I construct several measures of OWN to capture performance incentives and managerial voting control. In particular, I use the stock and option ownership in percent of shares outstanding, various

[11] To show this a bit differently, suppose we estimate the following OLS regressions (ignore, for simplicity, the exogenous variables $Y_L$):

$$IC = \beta \cdot Own + e \tag{ii}$$

$$Lev = \phi_0 + \phi_1 (IC - \beta Own) + \phi_2 Own + \varepsilon'_L \tag{iii}$$

By construction, e is the portion of IC that is uncorrelated with Own and Lev, and the coefficient estimate on e in eq. (iii), $\phi_1$, is unbiased. One can show that the estimate of $\phi_1$ is identical to the estimate of $\alpha_1$ in eq. (6), so again the estimate of $\alpha_1$ must be unbiased.

measures of the dollar value of CEO wealth (e.g., log of stock and options market value, with options valued using Black-Scholes), and the percentage or dollar change in CE caused by a given percentage or dollar increase in firm value. The coefficients on financing incentives in the level, changes, and probit regressions are robust to the inclusion of any of these measures, and for simplicity, and to be consistent with prior studies (e.g., Berger et al. (1997)), I report only regressions with stock and option ownership in percent of shares outstanding. In general, the evidence suggests that the endogeneity bias is not responsible for the positive association between incentives and leverage. However, one must keep in mind the potential shortcoming of this analysis. It is possible that, in spite of the long list of control variables, there are still some omitted factors in the leverage regressions that are correlated with incentives, and that the coefficient on IC is biased.

## 6 Summary and conclusions

The paper investigates how compensation affects firms' financing decisions. Compensation-induced financing incentives (or 'volatility costs' of debt) are measured as a change in the certainty equivalent of CEO wealth caused by a leverage increase. Thus, the incentive estimates take into account managers' risk aversion. The analysis suggests that the volatility costs of debt can be large. Contrary to the intuition in previous studies, options can substantially decrease the executive's preference for risk and debt, particularly if they are in-the-money. One implication of this result is that executives' preference for debt vs. equity can decline after option grants or after stock price increases. The volatility effect, which reflects the divergence between shareholders' and managers' incentives, varies strongly with firm characteristics (such as current firm volatility or leverage) and with the parameters of the compensation contracts (e.g., the proportions of stocks vs. options in the CEO portfolio, the options exercise price).

Empirically, I find that managers' incentives seem to affect actual financing choices. The tests use a wide variety of methodologies and control variables, all of which suggest that incentives are important. In particular, volatility costs seem to explain variation in both debt levels and debt changes across firms, and are a significant factor in a probit model of debt-equity choice. The findings are robust to several alternative specifications and to the inclusion of other determinants of financing decisions. Also, the results do not seem to be driven by the correlation of incentives with executive ownership.

The finding that leverage responds to managerial incentives is consistent with several interpretations. First, executives and employees likely require higher pay to compensate for their private costs of debt. In this case, shareholders would accept lower leverage to reduce compensation costs. Second, managers might influence leverage decisions because they have better information than shareholders (boards of directors) about the costs and benefits of debt. If it is costly to perfectly align managers' incentives with those of shareholders, leverage could temporarily deviate from its value-maximizing level in response to changes in managerial incentives. Finally, leverage decisions could be inefficient if governance mechanisms (e.g., boards of directors) fail to adequately monitor managers. This paper does not attempt to distinguish among these hypothesis. Instead, the point is more basic: executive compensation can have a large impact on managers' financing incentives and, perhaps more importantly, on observed financing decisions.

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## Appendix 1: Incentive contracts and aversion to stock volatility

This appendix provides additional intuition for the results in Section 2 and extends the analysis to more general utility functions. I derive simple analytical formulas to show how incentive contracts affect a CEO's attitude toward stock price risk. The framework and analysis are similar to Ross (2003).

Define the agent's derived utility from stock price as:

$$V(P) = U[f(P)], \tag{A1}$$

where f(P) the is agent's compensation as a function of stock prices (f(P) might represent the payoff from liquidating the CEO's portfolio). For simplicity, I follow Ross and assume that contracts are everywhere twice differentiable. This condition is violated at the point where options are at-the-money, so the expressions below should be viewed as approximations in that region (see Basak, Pavlova, and Shapiro (2002)). The standard definition of relative risk aversion is:

$$R_U(W) = -\frac{U''(W)}{U'(W)} \cdot W, \tag{A2}$$

where W is wealth, and U(W) is agent's utility from wealth. However, since we are interested in evaluating agent's aversion to *stock price* risk, I focus on a slightly modified measure of risk aversion, based on the derived utility from price, V(P):

$$R_V(P) = -\frac{V''(P)}{V'(P)} \cdot P \tag{A3}$$

I focus on *relative* risk aversion to be consistent with the power utility assumption used in the paper (Ross considers absolute risk aversion instead). Finally, we need to choose a benchmark to which our incentive scheme f(P) can be compared. To illustrate the effects of convexity or concavity of f(P), I choose as a benchmark a simple linear contract, equivalent to one share of stock that pays P at liquidation. The question is whether replacing one share of stock with f(P) will make the agent more or less averse to stock price risk in a close neighborhood of P. A simple way to do this is to compare the corresponding measures of risk aversion for the linear contract and for f(P) (note that the derived utility from one share of stock is simply U(P)):

$$\begin{aligned} R_V(P) - R_U(P) &= -\frac{U''(f)\cdot f'}{U'(f)} \cdot P - \left[-\frac{U''(P)}{U'(P)} \cdot P\right] + \left[-\frac{f''}{f'} \cdot P\right] \\ &= R_U(f)\cdot f' \cdot \frac{P}{f} - R_U(P) + R_f(P) \end{aligned}$$

$$= \left[R_U(f) - R_U(P)\right] + R_U(f) \cdot \left[\frac{P}{f} \cdot f' - 1\right] + R_f(P) \qquad \text{(A4)}$$

Eq. (A4) shows that the total effect of f(P) on agent's aversion to stock price risk can be decomposed into the following three effects:

- ***Convexity effect*** $= \left[-\frac{f''}{f'} \cdot P\right] = R_f(P)$

  The function $R_f(P)$ measures the convexity of the contract f(P). For convex contracts, $R_f(P)$ is negative, so that the convexity effect decreases the overall risk aversion. Consider the convex payoff in Figure 2 (on page 10 in the paper) associated with the stock-and-option portfolio. Call options introduce a kink into the derived utility function at the point when the options are at-the-money, and in this region, the resulting utility is convex. Unfortunately, the convexity effect cannot be evaluated at this point because the option payoff is non-differentiable. Nevertheless, the figure suggests that at- or close-to-the-money call options could induce more risk-taking than linear contracts.

- ***Magnification effect*** $= R_U(f) \cdot \left[\frac{P}{f} \cdot f' - 1\right]$

  Replacing a share of stock with f(P) magnifies the concavity of the derived utility if the price elasticity of f(P) (i.e., $P \cdot f'/f$ ) exceeds one. Intuitively, higher elasticity magnifies the impact of a given percentage change in stock price on a percentage change in f(P). Consequently, the magnification effect makes the agent more averse to stock price volatility. Consider again the payoff in Figure 2 that involves N shares of stock and M call options with exercise price of K. Note that for P > K, the payoff elasticity equals [P·(M+N)] / [P·(M+N) – M·K], which is always greater than one. This explains why option-based contracts can induce higher aversion to stock price volatility when options are in-the-money. Note also that the magnification effect declines with P, and approaches zero for highly in-the-money options.

- ***Translation effect*** $= R_U(f) - R_U(P)$

  Replacing a particular incentive scheme with another can make an agent more or less wealthy. Thus, depending on whether his risk aversion is decreasing or increasing in wealth, the contract could also increase or decrease agent's preference for risk. Note that this translation effect has little to do with the convexity or concavity of the contract. For example, the effect would occur even if we simply scaled the wealth up, leaving the shape of the payoff unchanged.

It is important to note that the analysis here uses a general concave utility function; it is ***not limited to CRRA utility***. Moreover, the direction and magnitude of the convexity and magnification effects depend primarily on the shape of the *contract* rather than the shape of the *utility* function. More precisely, the magnification effect includes the term $R_U(f)$, which depends on utility, but it is only a scaling factor. In that sense, a given contract induces similar magnification and convexity effects for different utility functions.

In contrast, the translation effect depends on whether risk aversion increases or decreases in wealth. The translation effect is completely eliminated for CRRA utility. Note, however, that most experiments in Section 2 of my paper hold wealth constant: for example, Figure 1 compares risk incentives of stocks vs. options by examining portfolios with different proportions of stocks and options but with the *same Black-Scholes value* (results are very similar when certainty equivalents are held constant instead). Since in this case, the translation effect is small, I expect that the qualitative results in Figure 1 are not sensitive to the choice of (concave) utility function. To check this, I replicate Figure 1 after replacing CRRA utility with Constant Absolute Risk Aversion (CARA) utility, $U(W) = -\exp(-\gamma \cdot W)$, where $\gamma$ is the risk aversion coefficient.[12] I find that replacing CRRA with CARA utility has little effect on the shape of the curves representing financing incentives in Figure 1. This is consistent with the analysis of the convexity, magnification, and translation effects discussed above.

## Appendix 2: Alternative model of incentives with risky debt

The estimation of financing incentives in Section 2 assumes that gross stock returns are log-normally distributed (before and after the leverage change) and that corporate debt is riskless. This appendix presents an alternative model to investigate how these simplifying assumptions affect the results in the paper.

### A. Estimation

In contrast to Section 2, I assume that *asset* returns $(1+\widetilde{R}_A)$, rather than stock returns, are log-normally distributed, with mean and standard deviation of $1+\theta_A$ and $\lambda_A$. Denote the continuously compounded asset return as $\widetilde{r}_A$, which is normally distributed:

$$\widetilde{r}_A = \log(1+\widetilde{R}_A) \sim N(\mu_A, \sigma_A) \tag{A6}$$

[12] I choose $\gamma$ of -0.0002 (wealth is measured in thousands of dollars), so that the incentives from holding a stock-

Shareholders hold a call option on corporate assets with exercise price equal to the face value of debt. Debtholders have a short position in the call. When debt matures, shareholders can exercise the option if they choose, i.e., they can pay of the debt and retain the firm's assets. They will choose to do so as long as the assets value at maturity exceeds the face value of debt. Given these assumptions, corporate claims can be valued using Black-Scholes. Although the model does not fully capture the complex default and bankruptcy procedures facing actual firms, it satisfies two key requirements needed for my robustness test. First, the model incorporates, in a straightforward way, the possibility of risky debt. Second, it allows me to explore alternative assumptions about the effects of leverage changes on stock return distribution.

Denote the face value of debt as F, the value of assets as A, and the value of equity as E. The Black-Scholes model implies that:

$$E = A \cdot N(X) - F \cdot e^{-T_D \hat{r}} \cdot N\left(X - \sigma_A \sqrt{T_D}\right) \tag{A7}$$

$$X = \frac{\log\left(A / F \cdot e^{-\hat{r} T_D}\right)}{\sigma_A \cdot \sqrt{T_D}} + \frac{1}{2} \cdot \sigma_A \cdot \sqrt{T_D}\,, \tag{A8}$$

where $T_D$ is time to maturity of debt, $\hat{r}$ is the instantaneous risk-free rate, and N(.) is the standard normal cumulative distribution function. Unfortunately, for many firms in my sample, asset values are unobserved because corporate debt is not publicly traded. Given this constraint, I break up the estimation of financing incentives into the following four steps. (1) I estimate A, $\sigma_A$, and $\mu_A$ using the Black-Scholes model and publicly available data. (2) Based on these estimates, I simulate the distribution of asset values and stock prices at the time of the CEO portfolio liquidation; stock prices are determined by Black-Scholes. (3) I repeat the second step for the new hypothetical leverage level. (4) I compute certainty equivalents and financing incentives, as in Section 2. Below, I describe the methodology in more detail.

*1) Estimating asset value, and the mean and standard deviation of asset returns*

The Black-Scholes model implies the following relations between the equity returns, $\tilde{r}$ , and the asset returns, $\tilde{r}_A$ :

$$\mu - \hat{r}_f = \Omega \cdot \left[\mu_A - \hat{r}_f\right] \tag{A9}$$

$$\sigma = \Omega \cdot \sigma_A\,, \tag{A10}$$

---

only portfolio are close to -1%, as in Figure 1. All other parameters are identical to those in Figure 1.

where the option's $\Omega$ is the elasticity of the option value with respect to the value of the underlying asset. Since, in this case, we are valuing equity as a call option on the firm's assets, the option's $\Omega$ can be written as:

$$\Omega = \frac{A}{E} \cdot N(X) = \frac{1}{1-L} \cdot N(X)\,, \qquad \text{(A11)}$$

Note that N(X) is option's delta defined in eq. (A8). To obtain the unknown parameters $\sigma_A$, $\mu_A$, and A, I solve numerically equations A(7) – (A10), using the actual current equity value as E, and the book value of debt as a proxy for $F \cdot e^{-T_D \hat{r}}$. For simplicity, I set $T_D$ to ten years for all firms, approximating the maturity of long-term debt.

Equations (A9) and A(10) 'unlever' the mean and standard deviation of stock returns when debt is risky. If leverage is relatively low, so that equity is strongly in-the-money and option's delta, N(X), is close to one, the 'unlevering' formulas (A9) and (A10) are almost identical to those used in the basic model in Section 2. Thus, it is not surprising that the basic model works fairly well for low-levered firms. (Note that more than a three quarters of the firms in my sample have relatively low debt, with market leverage below 30%.)

*2) Simulating the distribution of stock prices at the time of portfolio liquidation, T.*

As a next step, I simulate the distribution of asset values at the time of portfolio liquidation, T, using the previously estimated parameters, $\mu_A$, $\sigma_A$, and A:

$$\widetilde{A}_T = A \cdot e^{T \cdot \widetilde{r}_A} \quad \text{with} \quad \widetilde{r}_A \sim N(\mu_A, \sigma_A) \qquad \text{A(12)}$$

For each draw of asset value, I use the Black-Scholes formula to obtain equity value, $\widetilde{E}_T$, at time T. Finally, dividing the vector $\widetilde{E}_T$ by the number of shares outstanding, N, gives me the distribution of stock prices at time T, $\widetilde{P}_T$.

*3) Simulating the distribution of stock prices at time T at the new hypothetical leverage*

To compute financing incentives, I repeat the previous step after hypothetically increasing the firm's market leverage from $L^0$ to $L^1$ (recall that market leverage is defined as: book value of debt / (book value of debt + market value of equity)). A simple way to think about this problem is to assume that the leverage increase is accomplished by issuing debt and using the proceeds to repurchase shares. Denote the corresponding change in the book value of debt as d, and assume that d equals to the dollar proceeds from the issue. Assuming that the recapitalization has no effect on firm's *assets*, the distribution of asset values at time T is identical to that described in step (2), i.e., $\widetilde{A}_T^1 = \widetilde{A}_T$. Similarly, the distribution of *equity* values at time T at the new leverage, $\widetilde{E}_T^1$, can be easily simulated using Black-Scholes.

The only complication, compared to step (2), is that, to obtain the vector of *stock prices* at time T, we need to determine the number of shares outstanding after recapitalization. To do that, I first compute, using Black-Scholes, the value of equity after recapitalization, $E^1$. As soon as the recapitalization is announced, shareholders learn that their equity stake is worth, in aggregate, $E^1$ plus any cash they will receive from the share repurchase. Thus, the stock price at the announcement must equal: $P^1 = (E^1 + d) / N$. Since shares are repurchased at $P^1$, the number of shares outstanding after the recapitalization is: $N^1 = N - d / P^1$. This gives us all necessary ingredients to simulate the vector of stock prices at T as: $\widetilde{P}_T^1 = \widetilde{E}_T^1 / N^1$.

*4) Computation of financing incentives*

After simulating stock prices, certainty equivalents and incentives are computed as in Section 2. Note, however, a key difference with Section 2. In the basic model of Section 2, a leverage change affects the distribution of stock returns but leaves the current price unchanged. Thus, IC measures only the 'volatility effect' of debt on CEO welfare. In contrast, the Black-Scholes approach in this section implicitly assumes that an increase in leverage transfers wealth from old bondholders to shareholders. This wealth transfer is reflected in the stock price increase following the recapitalization announcement (from $P^0$ to $P^1$). Consequently, the new incentives estimate, $IC^B$, measures the impact of a leverage change on the CEO through two separate effects: (1) the volatility effect, and (2) the wealth transfer effect.

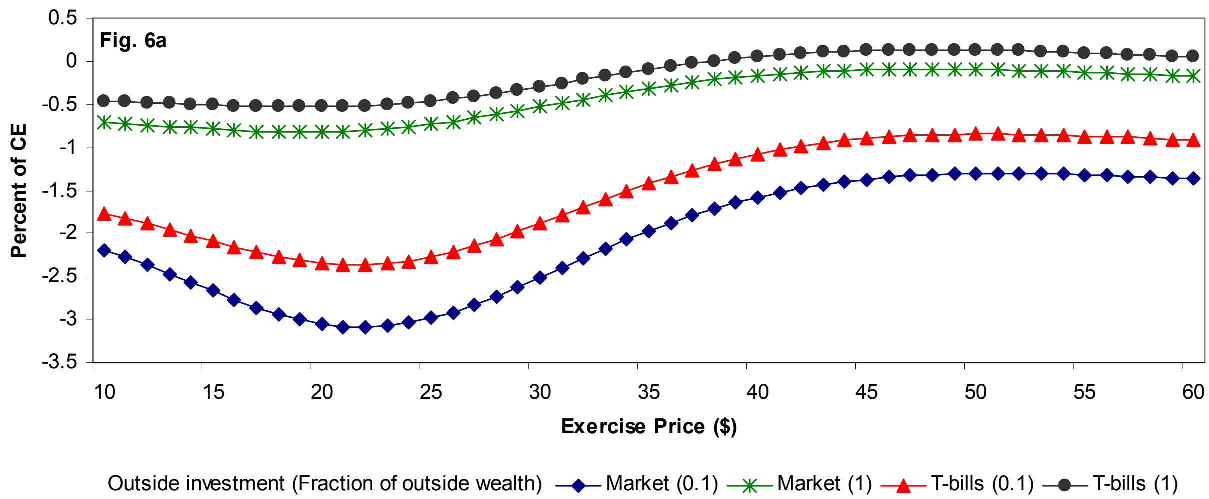
Since this paper focuses on the *volatility costs* of leverage, I compute an alternative measure of financing incentives that tries to isolate these costs. This alternative variable (denoted $IC^{BV}$) is obtained similarly to $IC^B$, except that, before computing the certainty equivalent at $L^1$, I multiply $\widetilde{P}_T^1$ by a factor $P^0 / P^1$. This factor adjusts the incentives estimate for the stock price appreciation at the announcement, caused by the wealth transfer. All the remaining steps in the calculation follow exactly the algorithm described in this appendix

## B. Results

The new estimates of incentives ($IC^{BV}$) are less negative but similar in magnitude to the old estimates in Table 5 (IC). For example, the mean (median) $IC^{BV}$ is -3.16% (-2.8%) and the mean (median) IC is -5.12% (-4.1%). These differences are not surprising. The original method in Section 2 assumes that debt is riskless before and after the leverage change. In contrast, the Black-Scholes approach takes into account that, as leverage increases, debt becomes more volatile, thereby dampening the impact on stock volatility and the CEO's certainty equivalent. The discrepancy between the two models should be more pronounced for highly levered firms, for which the assumption of riskfree debt is likely violated. To check this, I look separately at a sub-sample of firms with below-median market leverage (the median is 15%). As expected, the difference between $IC^{BV}$ and IC is much smaller for these firms, with mean (median) $IC^{BV}$ of -3.43% (-3.16%) and the mean (median) IC of -3.97% (-3.48%). Similarly, the correlation between $IC^{BV}$ and IC is 87% for the sub-sample with below-median leverage, and it is 47% for the whole sample.

As a robustness test, I re-run all tests in the paper using the new set of estimates. The results in the probit model are somewhat stronger than those in Table 6, and they are similar when the pure volatility effect ($IC^{BV}$) or the combined volatility and wealth effect ($IC^{B}$) is used to measure incentives. As described earlier in Section 5.2, the results in the change regressions are weaker when the new incentives estimate is used. Although the coefficients on $\Delta IC^{BV}$ (and $\Delta IC^{B}$) are still positive, they are smaller than in Table 7 and are not statistically significant. Finally, to test the robustness of the leverage level regressions, I estimate financing incentives at zero leverage using the Black-Scholes approach. These estimates are very highly correlated with the original estimates (the correlation in is 94%), and the regression results are similar, independently of which estimate I use. Overall, the empirical evidence in this section supports the hypothesis that volatility costs help explain firms' financial structure.

**Appendix 3: Financing incentives for different assumptions about the investment of outside wealth and holding period.**



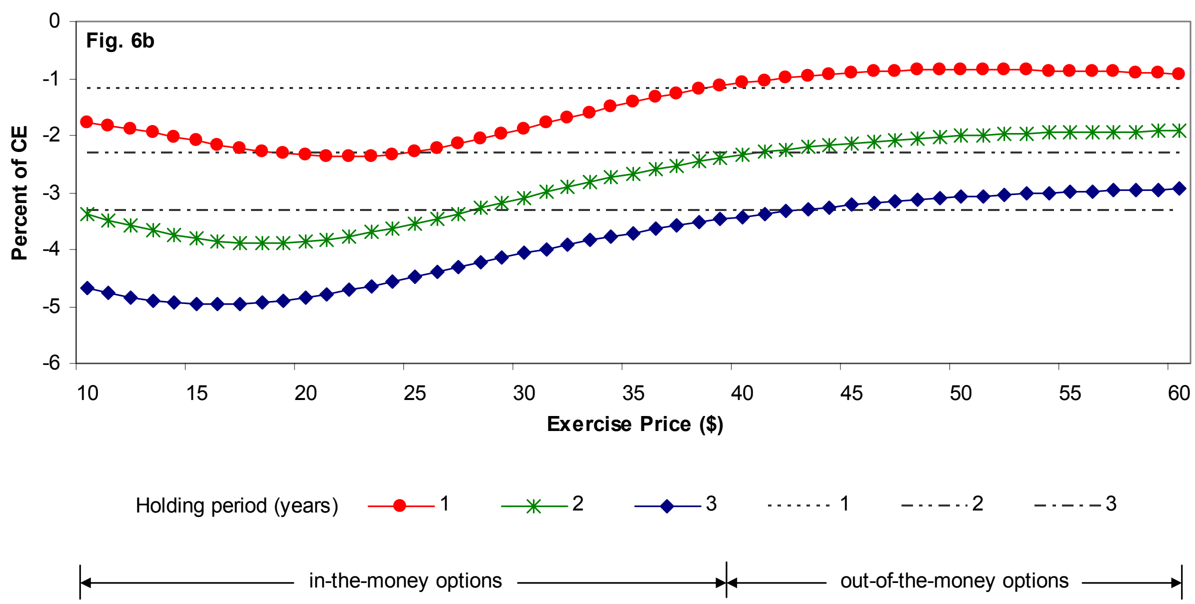




**Fig. 6:** Financing incentives are measured as the percentage change in certainty equivalent of CEO wealth caused by a 10 percentage points leverage increase. The CEO has a CRRA utility function with a risk-aversion parameter of 2. The parameters are: stock price = $40; asset beta = 0.7; market leverage = 15%; asset volatility = 28%; CEO's portfolio = 200,000 options, 216,000 shares and outside wealth. In **Fig. 6a**, outside wealth equals 10% or 100% of the stocks and options value, and it is invested in T-Bills or in the market portfolio. The assumed return standard deviation for the market portfolio is 0.2. The holding period is one year. In **Fig. 6b**, outside wealth equals 10% of the stocks and options value, and it is invested in T-Bills. The holding period is varied from one to three years. The dashed lines in Fig. 6b represent shares portfolios constructed as follows: for each stock and option portfolio depicted in the figure, I replace all options with shares of the same value while holding everything else constant.

## Appendix 4: Variables definitions

| | |
|---|---|
| IC | Financing incentives: Percentage change in the certainty equivalent of CEO wealth caused by a 10% leverage increase (see section 2.1 for details). |
| Shares | Shares ownership = number of shares owned by the CEO in percent of shares outstanding. |
| Options | Option ownership = number of options owned by the CEO in percent of shares outstanding. |
| Wealth | Value of the CEO stock and option portfolio ($ mil). Options are valued using Black-Scholes. |
| Options value | Value of the CEO option portfolio computed using Black-Scholes ($ mil.) |
| Book leverage | Book leverage = [total debt/(book value of common stock + total debt)]·100. |
| Market leverage | Market leverage = [total debt/(market value of common stock + total debt)]·100. |
| Book assets | Book value of total assets ($ bill.). The regressions use log(BV) as an explanatory variable. |
| Market assets | Market value of total assets ($ bill.) = (Book assets – book value of common stock + market value of common stock). |
| M/B | Market-to-book ratio = market value of common stock/book value of common stock. |
| PPE | Property, plant & equipment plus inventory in percent of total assets.[1] |
| R&D | R&D expense in percent of total assets.[1] |
| Advertising | Advertising expense in percent of sales.[1] |
| Depreciation | Depreciation expense in percent of total assets. |
| $MTR^1$ ($MTR^2$) | Graham's (1996) marginal tax rate before (after) interest expense (%). |
| Z-score | Altman's (1968) Z-score = (3.3·EBIT + 1.0·sales + 1.4·retained earnings + 1.2·net working capital)/Book assets. Inverse of the z-score is a proxy for the probability of bankruptcy. |
| Herfindahl | Herfindahl index computed based on company's sales and 47 Fama and French (1997) industries. |
| Dividend | Dummy variable equal to one if the firm pays dividends. |
| ROA | Net income in percent total assets. |
| Stock return | Stock return over the past fiscal year (%). |
| Volatility | Standard deviation of stock returns (%) computed from weekly returns over the past three fiscal years. At least 50 weeks of stock return data are required for the computation. |
| Asset volatility | [1/(1 – Market leverage/100)] · Volatility |
| Asset beta | [1/(1 – Market leverage/100)] · Beta. Beta is computed from weekly returns over the past three fiscal years. At least 50 weeks of stock return data are required for the computation. |
| TARGET | Target leverage = fitted values from a regression of book leverage on M/B, PPE, R&D, log(Book assets), Advertising, Depretiation, Herfindahl, Dividend, year dummies, and 48 Fama and French (1997) industry dummies. |
| Issue size | Issue size in percent of the market value of common stock. |

[1] Compustat missing values for R&D expense, PP&E, inventories and advertising expense are set to zero.

Table 1

Financing incentives are measured as the percentage change in certainty equivalent of CEO wealth caused by a 10 percentage points leverage increase. I assume that a leverage increase affects the certainty equivalent of CEO's wealth through its impact on stock return volatility. The CEO holds firm's shares, stock options, and outside wealth invested in T-Bills. In the benchmark case, the CEO holds 200,000 options and 216,000 shares, so that the ratio of number of options to number of shares is close to the sample median. Starting from this benchmark the number of options is varied from 600,000 ("High") to zero, and the number of shares is adjusted to keep the market value of the total portfolio constant. The amount of T-Bills is expressed in percent of the stocks and options value (options are valued using Black-Scholes model). The CEO has a CRRA utility function with a risk aversion coefficient varying from 2 to 5. Other parameters are: stock price = $40; exercise price = $30; asset volatility = 28%; asset beta = 0.7; market leverage = 15%; portfolio holding period = one year.

| Risk aversion | Fraction of options | T-Bills in % of stock and option portfolio value | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | 200% |
| 5 | High | -9.57 | -7.01 | -5.83 | -5.03 | -4.41 | -3.91 | -3.50 | -3.14 | -2.84 | -2.58 | -2.36 | -1.10 |
| | Median | -6.61 | -5.00 | -4.02 | -3.34 | -2.83 | -2.44 | -2.13 | -1.88 | -1.67 | -1.49 | -1.34 | -0.56 |
| | Zero | -4.74 | -3.57 | -2.84 | -2.33 | -1.95 | -1.67 | -1.44 | -1.26 | -1.11 | -0.99 | -0.88 | -0.35 |
| 4 | High | -10.15 | -7.49 | -6.07 | -5.09 | -4.35 | -3.77 | -3.31 | -2.92 | -2.60 | -2.33 | -2.10 | -0.89 |
| | Median | -5.66 | -4.30 | -3.44 | -2.84 | -2.39 | -2.04 | -1.77 | -1.55 | -1.36 | -1.21 | -1.08 | -0.42 |
| | Zero | -3.68 | -2.82 | -2.25 | -1.85 | -1.55 | -1.32 | -1.14 | -0.99 | -0.87 | -0.77 | -0.68 | -0.26 |
| 3 | High | -10.47 | -7.42 | -5.74 | -4.64 | -3.84 | -3.25 | -2.78 | -2.41 | -2.11 | -1.86 | -1.65 | -0.61 |
| | Median | -4.39 | -3.33 | -2.65 | -2.16 | -1.80 | -1.52 | -1.30 | -1.13 | -0.98 | -0.86 | -0.76 | -0.25 |
| | Zero | -2.62 | -2.02 | -1.62 | -1.33 | -1.11 | -0.94 | -0.80 | -0.69 | -0.60 | -0.53 | -0.46 | -0.15 |
| 2 | High | -8.46 | -5.65 | -4.18 | -3.26 | -2.62 | -2.15 | -1.79 | -1.51 | -1.29 | -1.11 | -0.96 | -0.24 |
| | Median | -2.73 | -2.06 | -1.62 | -1.30 | -1.06 | -0.87 | -0.73 | -0.61 | -0.52 | -0.44 | -0.37 | -0.06 |
| | Zero | -1.54 | -1.19 | -0.94 | -0.76 | -0.63 | -0.52 | -0.43 | -0.37 | -0.31 | -0.26 | -0.22 | -0.04 |

Table 2
Sample construction

| | Firm-years | Firms |
|---|---|---|
| **Initial sample** | | |
| Execucomp database for years 1993 – 2001 | 13,580 | 2,502 |
| Missing compensation or ownership data | 13,324 | 2,496 |
| **Computation of incentives**[1] | | |
| Excluding observations with negative exercise price estimates | 13,234 | 2,479 |
| Excluding observations with inconsistent option reporting[2] | 11,908 | 2,441 |
| Missing price data (CRSP) [3] | 11,333 | 2,335 |
| Missing leverage data (Compustat) | 11,138 | 2,305 |
| **Final samples** | | |
| Excluding financial firms (SIC codes 6000 – 6999) | 9,727 | 1,969 |
| Excluding utilities (SIC codes 4900 – 4999) | 8,897 | 1,823 |
| Excluding observations with negative book value of equity | 8,740 | 1,810 |
| Excluding observations with zero wealth | 8,718 | 1,809 |
| Excluding observations with market leverage < 90%[4] | 8,700 | 1,809 |
| *A. Leverage-level regressions* | | |
| Missing control variables | **7,255** | **1,587** |
| *B. Debt / equity issue regressions* | | |
| Firms on Compustat in years t and t+1 | 7,880 | 1,727 |
| Issuers sample[5] | 3,519 (1,223) | 1,445 (714) |
| Missing control variables | **2,857 (957)** | **1,242 (593)** |
| *C. Leverage-change regressions* | | |
| Firms on Compustat in years t-1 through t+1 | 7,878 | 1,724 |
| Missing control variables | **6,333** | **1,504** |

[1] The computation of incentives is described in Section 2.1.
[2] The consistency check is whether the number of options owned in a given year equals the number of options owned in the previous year plus option granted and minus options exercised in the current year. The incentive estimates are set to missing for years in which this relation is violated by more than 50,000 options.
[3] The computation of stock return volatility and beta requires at least 50 weeks of past return data.
[4] Financing incentives associated with a 10 percentage point leverage increase cannot be computed to for highly levered firms.
[5] Issuers sample consists of firm-year observations with a net debt (equity) issue larger than 1% of total assets. Net debt issue = long-term debt issued – long-term debt retired. Net equity issue = sale of common and preferred stock – purchase of common and preferred stock. Equity issuers are in parentheses.

Table 3
Descriptive statistics for a sample of 7,255 firm-years (1,587 firms) in years 1993 through 2001
The variables definitions are in Appendix 4. BOOK ASSETS and MARKET ASSETS ($ bill.) is book value and market value of total assets, respectively. M/B is the ratio of market value of equity to book value of equity. R&D is R&D expense in percent of total assets. PPE is PP&E plus inventory in percent of total assets. DEPRECIATION is depreciation expense in percent of total assets. $MTR^2$ (%) is the Graham's (1996) simulated marginal tax rate after interest expense. DIVIDEND is a dummy variable equal to one if the firm pays dividends. VOLATILITY (%) is the annualized standard deviation of stock returns. STOCK RETURN (%) is the past-year stock return. ROA is net income in percent of total assets. SHARES (OPTIONS) is the number of shares (options) owned by the CEO in percent of shares outstanding. WEALTH ($ mil.) is the dollar value of the CEO stock and option portfolio. OPTIONS VALUE ($ mil.) is the Black-Scholes value of the CEO option portfolio. IC are financing incentives.

| | Level regressions | | Probit – All firms | | Probit – Debt issuers | | Probit – Equity issuers | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Mean | Median | Mean | Median | Mean | Median |
| Book assets | 3.92 | 0.91 | 3.29 | 0.85 | 4.11 | 1.19 | 1.66 | 0.37 |
| Market assets | 8.34 | 1.60 | 7.57 | 1.58 | 8.46 | 1.99 | 5.80 | 1.01 |
| M/B | 4.86 | 2.51 | 3.99 | 2.70 | 3.33 | 2.42 | 5.31 | 3.67 |
| R&D | 3.36 | 0.20 | 3.77 | 0.30 | 1.64 | 0.00 | 8.00 | 4.88 |
| PPE | 47.52 | 47.32 | 48.17 | 48.14 | 53.90 | 54.11 | 36.81 | 33.11 |
| Depreciation | 4.88 | 4.42 | 4.92 | 4.47 | 4.96 | 4.60 | 4.84 | 4.19 |
| $MTR^2$ | 24.77 | 35.00 | 24.98 | 35.00 | 26.39 | 35.00 | 22.18 | 35.00 |
| Dividend | 0.60 | 1.00 | 0.55 | 1.00 | 0.70 | 1.00 | 0.25 | 0.00 |
| Market leverage | 19.75 | 14.98 | 18.25 | 14.28 | 21.88 | 18.27 | 11.06 | 4.11 |
| Book leverage | 32.09 | 32.33 | 31.77 | 32.19 | 36.62 | 37.37 | 22.15 | 14.47 |
| Volatility | 40.65 | 37.05 | 41.92 | 37.38 | 35.63 | 33.03 | 54.40 | 52.07 |
| Stock return | 19.33 | 8.19 | 27.28 | 12.68 | 13.78 | 7.52 | 54.09 | 27.63 |
| ROA | 5.01 | 5.79 | 4.95 | 6.11 | 6.07 | 5.98 | 2.72 | 6.35 |
| Shares | 3.49 | 0.49 | 3.28 | 0.51 | 2.73 | 0.42 | 4.37 | 0.92 |
| Options | 1.05 | 0.58 | 1.06 | 0.59 | 0.96 | 0.53 | 1.25 | 0.76 |
| Wealth | 114.04 | 13.18 | 104.79 | 14.28 | 79.39 | 12.66 | 155.22 | 19.42 |
| Options value | 13.01 | 2.46 | 15.36 | 2.86 | 12.32 | 2.60 | 21.40 | 3.55 |
| IC | -5.12 | -4.08 | -4.96 | -4.07 | -4.57 | -3.52 | -5.76 | -5.15 |
| N | 7,255 | | 2,857 | | 1,900 | | 957 | |

Table 4

Correlation matrix for a sample of 7,255 firm-years (1,587 firms) in years 1993 through 2001

The variables definitions are in Appendix 4. BOOK ASSETS and MARKET ASSETS ($ bill.) is book value and market value of total assets, respectively. M/B is the ratio of market value of equity to book value of equity. R&D is R&D expense in percent of total assets. PPE is PP&E plus inventory in percent of total assets. $MTR^2$ (%) is the Graham's (1996) simulated marginal tax rate after interest expense. DIVIDEND is a dummy variable equal to one if the firm pays dividends. VOLATILITY (%) is the annualized standard deviation of stock returns. STOCK RETURN (%) is the past-year stock return. ROA is net income in percent of total assets. SHARES (OPTIONS) is the number of shares (options) owned by the CEO in percent of shares outstanding. WEALTH ($ mil.) is the dollar value of the CEO stock and option portfolio. OPTIONS VALUE ($ mil.) is the Black-Scholes value of the CEO option portfolio. IC are financing incentives.

| | Book assets | Market assets | M/B | R&D | PPE | $MTR^2$ | Divi-dend | Market lever. | Book lever. | Vola-tility | Stock return | ROA | Shares | Options | Wealth | Options value | IC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Book assets | **1.00** | 0.78 | 0.00 | -0.04 | -0.03 | 0.02 | 0.16 | 0.11 | 0.18 | -0.14 | -0.03 | 0.01 | -0.11 | -0.12 | 0.07 | 0.17 | -0.04 |
| Market assets | 0.78 | 1.00 | 0.01 | 0.03 | -0.07 | 0.05 | 0.13 | -0.04 | 0.07 | -0.12 | 0.03 | 0.08 | -0.09 | -0.13 | 0.34 | 0.36 | 0.03 |
| M/B | 0.00 | 0.01 | **1.00** | 0.01 | -0.01 | -0.02 | -0.02 | -0.01 | 0.05 | 0.00 | 0.16 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 |
| R&D | -0.04 | 0.03 | 0.01 | **1.00** | -0.32 | -0.18 | -0.26 | -0.28 | -0.28 | 0.33 | 0.07 | -0.38 | -0.07 | 0.15 | 0.02 | 0.05 | 0.01 |
| PPE | -0.03 | -0.07 | -0.01 | -0.32 | **1.00** | 0.06 | 0.19 | 0.27 | 0.22 | -0.25 | -0.13 | 0.01 | 0.03 | -0.11 | -0.06 | -0.14 | -0.01 |
| $MTR^2$ | 0.02 | 0.05 | -0.02 | -0.18 | 0.06 | **1.00** | 0.17 | -0.18 | -0.13 | -0.25 | 0.04 | 0.32 | 0.09 | -0.12 | 0.02 | 0.01 | 0.18 |
| Dividend | 0.16 | 0.13 | -0.02 | -0.26 | 0.19 | 0.17 | **1.00** | 0.08 | 0.16 | -0.58 | -0.13 | 0.14 | -0.10 | -0.22 | -0.04 | -0.04 | 0.20 |
| Market leverage | 0.11 | -0.04 | -0.01 | -0.28 | 0.27 | -0.18 | 0.08 | **1.00** | 0.81 | -0.05 | -0.23 | -0.24 | -0.09 | 0.08 | -0.06 | -0.11 | -0.47 |
| Book leverage | 0.18 | 0.07 | 0.05 | -0.28 | 0.22 | -0.13 | 0.16 | 0.81 | **1.00** | -0.18 | -0.11 | -0.18 | -0.15 | 0.00 | -0.05 | -0.03 | -0.30 |
| Volatility | -0.14 | -0.12 | 0.00 | 0.33 | -0.25 | -0.25 | -0.58 | -0.05 | -0.18 | **1.00** | 0.14 | -0.26 | 0.08 | 0.28 | 0.00 | 0.06 | -0.34 |
| Stock return | -0.03 | 0.03 | 0.16 | 0.07 | -0.13 | 0.04 | -0.13 | -0.23 | -0.11 | 0.14 | **1.00** | 0.12 | 0.03 | -0.03 | 0.05 | 0.16 | 0.01 |
| ROA | 0.01 | 0.08 | 0.01 | -0.38 | 0.01 | 0.32 | 0.14 | -0.24 | -0.18 | -0.26 | 0.12 | **1.00** | 0.07 | -0.18 | 0.05 | 0.06 | 0.16 |
| Shares | -0.11 | -0.09 | 0.00 | -0.07 | 0.03 | 0.09 | -0.10 | -0.09 | -0.15 | 0.08 | 0.03 | 0.07 | **1.00** | -0.02 | 0.15 | -0.01 | 0.08 |
| Options | -0.12 | -0.13 | 0.00 | 0.15 | -0.11 | -0.12 | -0.22 | 0.08 | 0.00 | 0.28 | -0.03 | -0.18 | -0.02 | **1.00** | -0.02 | 0.08 | -0.17 |
| Wealth | 0.07 | 0.34 | 0.01 | 0.02 | -0.06 | 0.02 | -0.04 | -0.06 | -0.05 | 0.00 | 0.05 | 0.05 | 0.15 | -0.02 | **1.00** | 0.18 | 0.04 |
| Options value | 0.17 | 0.36 | 0.01 | 0.05 | -0.14 | 0.01 | -0.04 | -0.11 | -0.03 | 0.06 | 0.16 | 0.06 | -0.01 | 0.08 | 0.18 | **1.00** | 0.01 |
| IC | -0.04 | 0.03 | 0.01 | 0.01 | -0.01 | 0.18 | 0.20 | -0.47 | -0.30 | -0.34 | 0.01 | 0.16 | 0.08 | -0.17 | 0.04 | 0.01 | **1.00** |

Table 5
Descriptive statistic for financing incentives for 7,255 firm-years (1,587 firms) in years 1993 – 2001
Financing incentives are measured as the percentage change in the certainty equivalent of CEO wealth caused by a 10% leverage increase. TB (%) is the assumed amount of fixed wealth in the CEO portfolio (in percent of the stock and option portfolio value); RISK AV. is the assumed coefficient of the CEO risk aversion (CRRA utility). Panels A and B show descriptive statistics and correlation matrix for financing incentives estimated under different assumptions. Panel C shows descriptive statistics for the parameters used to estimate financing incentives. SHARES RATIO is the number of shares owned by the CEO divided by the number of shares and options owned by the CEO (in percent). PRICE / STRIKE is the closing price for the fiscal year divided by the weighted average of the exercise prices of all options owned by the CEO in the fiscal year. The exercise prices are weighted by the number of options. The remaining variables in Panel C are defined in Appendix 4.

*Panel A: Descriptive statistics for incentives estimates*

| Risk av., TB | Mean | Std | P1 | Median | P99 |
|---|---|---|---|---|---|
| 2,10 | -3.46 | 4.06 | -17.58 | -2.51 | 0.21 |
| 3,10 | -5.12 | 4.83 | -22.45 | -4.08 | -0.40 |
| 2,100 | -0.50 | 1.12 | -3.31 | -0.36 | 1.31 |
| 3,100 | -1.04 | 1.34 | -5.32 | -0.82 | 0.39 |

*Panel B: Correlation table for incentives estimates*

| Risk av., TB | 2,10 | 3,10 | 2,100 | 3,100 |
|---|---|---|---|---|
| 2,10 | **1.00** | 0.90 | 0.98 | 0.97 |
| 3,10 | 0.90 | **1.00** | 0.87 | 0.96 |
| 2,100 | 0.98 | 0.87 | **1.00** | 0.96 |
| 3,100 | 0.97 | 0.96 | 0.96 | **1.00** |

*Panel C: Descriptive statistics for the parameters used to estimate financing incentives*

| | Mean | Std | P1 | Median | P99 |
|---|---|---|---|---|---|
| Asset volatility | 32.84 | 17.11 | 9.81 | 28.22 | 88.34 |
| Asset beta | 0.79 | 0.51 | 0.01 | 0.68 | 2.35 |
| Market leverage | 19.75 | 18.65 | 0.00 | 14.98 | 75.54 |
| Shares ratio | 48.95 | 34.38 | 0.00 | 43.04 | 100.00 |
| Price / Strike | 1.94 | 2.98 | 0.37 | 1.33 | 11.56 |
| Wealth | 114.04 | 1,279.71 | 0.17 | 13.18 | 1,467.18 |

Table 6

Probit model of debt-equity issue choice for 2,857 firm-years (1,242 firms) in years 1993 through 2001

Variables definitions are in Appendix 4. The model estimates the probability of a debt issue. All variables are for the fiscal year preceding the issue. IC are financing incentives. SHARES (OPTIONS) is the number of shares (options) owned by the CEO in percent of shares outstanding. In columns 1-3, TARGET is the fitted value from a book-leverage regression (see Appendix 4). In column 4, the fitted value is replaced by the independent variables from the book-leverage regression. VOLATILITY (%) is the annualized standard deviation of stock returns. STOCK RETURN (%) is the past-year stock return. M/B is the ratio of market value of equity to book value of equity. ISSUE SIZE is in percent of the market value of common stock. $MTR^2$ (%) is the Graham's (1996) marginal tax rate after interest expense. Z-SCORE is Altman's (1968) Z-score. All regressions include industry dummies, all panel regressions include year dummies. T-statistics are in parentheses. Fama-MacBeth t-statistics are in italic.

| | | | | |
|---|---|---|---|---|
| IC | 0.07 | 0.06 | 0.04 | 0.04 |
| | (8.67) | (8.29) | (5.41) | (4.64) |
| | *(5.12)* | *(5.44)* | *(3.75)* | *(3.41)* |
| Shares | -0.02 | | -0.01 | -0.01 |
| | (-4.84) | | (-3.13) | (-3.27) |
| | *(-2.51)* | | *(-1.80)* | *(-2.10)* |
| Options | 0.04 | | 0.05 | 0.06 |
| | (1.64) | | (2.15) | (2.71) |
| | *(1.29)* | | *(1.55)* | *(2.14)* |
| Book Leverage | 0.01 | 0.01 | 0.01 | 0.00 |
| | (5.48) | (5.79) | (3.96) | (1.41) |
| | *(3.92)* | *(4.03)* | *(3.79)* | *(0.91)* |
| Target | 0.03 | 0.03 | 0.02 | |
| | (8.63) | (9.09) | (5.65) | |
| | *(5.36)* | *(5.23)* | *(4.61)* | |
| Volatility | | | -0.02 | -0.01 |
| | | | (-7.38) | (-3.35) |
| | | | *(-4.78)* | *(-1.26)* |
| Stock return | 0.00 | 0.00 | 0.00 | 0.00 |
| | (-4.77) | (-4.95) | (-4.16) | (-4.16) |
| | *(-3.30)* | *(-3.76)* | *(-2.82)* | *(-3.86)* |
| M/B | -0.04 | -0.05 | -0.03 | -0.01 |
| | (-5.66) | (-5.93) | (-4.32) | (-1.24) |
| | *(-5.88)* | *(-5.80)* | *(-5.26)* | *(-0.88)* |
| ROA | 0.02 | 0.02 | 0.01 | 0.01 |
| | (3.53) | (3.48) | (2.75) | (1.52) |
| | *(4.21)* | *(4.01)* | *(4.54)* | *(3.07)* |
| Issue size | 0.01 | 0.01 | 0.01 | 0.01 |
| | (5.71) | (5.45) | (5.66) | (5.64) |
| | *(3.10)* | *(3.11)* | *(3.23)* | *(3.20)* |
| $MTR^2$ | 0.01 | 0.01 | 0.00 | 0.00 |
| | (2.61) | (2.33) | (1.80) | (1.45) |
| | *(1.52)* | *(1.41)* | *(1.21)* | *(0.97)* |
| Z-prob | 0.03 | 0.02 | -0.01 | -0.05 |
| | (0.81) | (0.47) | (-0.26) | (-1.18) |
| | *(1.36)* | *(1.12)* | *(0.94)* | *(-0.00)* |

Table 7

Debt-change regressions for 6,333 firm-years (1,504 firms) in years 1993 through 2001

The variables definitions are in Appendix 4. The dependent variable, $\Delta Debt_{t+1}$, is the change in debt from year t to t+1 scaled by book value of assets in year t. The regressions use $\log(1 + \Delta Debt_{t+1})\cdot 100$. Subscript t for changes indicates a change from year t-1 to t. ΔIC is the change in financing incentives. ΔSHARES (ΔOPTIONS) is the change in the number of shares (options) owned by the CEO in percent of lagged shares outstanding. ΔBOOK ASSETS (ΔNET INCOME) is the change in book value of assets (in net income) in percent of lagged assets. In columns 1-3, TARGET is the fitted value from a book-leverage regression (see Appendix 4). In column 4, the fitted value is replaced by the independent variables from the regression. VOLATILITY is standard deviation of stock returns. STOCK RETURN is past-year stock return. All regressions include industry dummies, all panel regressions include year dummies. T-statistics are in parentheses. Fama-MacBeth t-statistics are in italic.

| | | | | |
|---|---|---|---|---|
| $\Delta IC_t$ | 0.10 | 0.10 | 0.08 | 0.10 |
| | (2.87) | (2.94) | (2.33) | (2.91) |
| | *(1.94)* | *(1.89)* | *(1.82)* | *(1.97)* |
| $\Delta Shares_t$ | 0.04 | | 0.04 | 0.04 |
| | (0.97) | | (1.00) | (0.94) |
| | *(1.07)* | | *(1.19)* | *(0.97)* |
| $\Delta Options_t$ | 0.09 | | -0.01 | 0.12 |
| | (0.63) | | (-0.04) | (0.82) |
| | *(-0.42)* | | *(-0.68)* | *(-0.60)* |
| $\Delta$Net income$_{t+1}$ | -0.11 | -0.11 | -0.12 | -0.11 |
| | (-9.37) | (-9.39) | (-10.27) | (-9.20) |
| | *(-3.48)* | *(-3.39)* | *(-3.79)* | *(-4.34)* |
| $\Delta$Net income$_t$ | -0.06 | -0.06 | -0.08 | -0.06 |
| | (-4.30) | (-4.38) | (-5.91) | (-4.33) |
| | *(-1.28)* | *(-1.33)* | *(-2.02)* | *(-1.56)* |
| $\Delta$Book assets$_{t+1}$ | 0.23 | 0.23 | 0.23 | 0.24 |
| | (66.79) | (66.81) | (66.28) | (66.71) |
| | *(9.98)* | *(9.99)* | *(9.59)* | *(10.10)* |
| $\Delta$Book assets$_t$ | -0.01 | -0.01 | -0.02 | -0.01 |
| | (-1.13) | (-1.11) | (-2.78) | (-0.92) |
| | *(-1.95)* | *(-1.92)* | *(-2.56)* | *(-1.72)* |
| $Target_t$ | -0.01 | -0.01 | 0.02 | |
| | (-0.52) | (-0.55) | (1.08) | |
| | *(0.78)* | *(0.78)* | *(1.36)* | |
| Book leverage$_t$ | -0.03 | -0.03 | -0.03 | -0.03 |
| | (-4.37) | (-4.30) | (-4.32) | (-5.01) |
| | *(-2.13)* | *(-2.15)* | *(-2.20)* | *(-2.15)* |
| $Volatility_t$ | -0.04 | -0.04 | | -0.02 |
| | (-4.19) | (-4.19) | | (-1.97) |
| | *(-3.45)* | *(-3.61)* | | *(-0.50)* |
| Stock return$_t$ | -0.02 | -0.02 | | -0.01 |
| | (-7.24) | (-7.21) | | (-5.87) |
| | *(-4.36)* | *(-4.33)* | | *(-3.69)* |
| Adj. $R^2$ | 0.44 | 0.44 | 0.44 | 0.45 |

Table 8

Leverage regressions for 7,255 firm-years (1,587 firms) in years 1993 through 2001

Variables definitions are in Appendix 4. $IC^0$ are financing incentives at zero leverage. SHARES (OPTIONS) is the number of shares (options) owned by the CEO in percent of shares outstanding. M/B is the ratio of market value of equity to book value of equity. BOOK ASSETS ($ bill.) is the book value of total assets. PPE, R&D, and DEPRECIATION are: PP&E and inventory, R&D expense, depreciation expense, all variables in percent of total assets. Advertising is advertising expense in percent of sales. $MTR^1$ (%) is the Graham's (1996) simulated marginal tax rate before interest expense. DIVIDEND is a dummy variable equal to one if the firm pays dividends. All regressions include industry dummies and year dummies. Panel T-statistics are in parentheses.

| Dependent variable: | Market leverage (%) | | | Book leverage (%) | | |
|---|---|---|---|---|---|---|
| $IC^0$ | 2.52 | 2.30 | 1.05 | 1.89 | 1.63 | 0.48 |
| | (29.08) | (26.39) | (12.54) | (17.66) | (15.15) | (4.37) |
| Shares | -0.24 | | -0.10 | -0.33 | | -0.20 |
| | (-9.44) | | (-4.62) | (-10.52) | | (-6.79) |
| Options | 1.97 | | 1.61 | 1.85 | | 1.50 |
| | (16.89) | | (15.85) | (12.75) | | (11.18) |
| M/B | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.01 |
| | (-0.70) | (-0.64) | (-1.21) | (5.77) | (5.71) | (5.96) |
| PPE | 0.14 | 0.13 | 0.06 | 0.11 | 0.11 | 0.04 |
| | (12.05) | (11.28) | (5.98) | (8.01) | (7.43) | (2.91) |
| R&D | -0.30 | -0.24 | -0.04 | -0.38 | -0.32 | -0.13 |
| | (-9.43) | (-7.39) | (-1.37) | (-9.56) | (-7.84) | (-3.35) |
| Log(Book assets) | 2.92 | 2.83 | 1.48 | 5.49 | 5.56 | 4.11 |
| | (20.69) | (20.65) | (10.76) | (31.37) | (32.91) | (22.75) |
| Advertising | -0.32 | -0.30 | -0.26 | -0.16 | -0.15 | -0.10 |
| | (-4.94) | (-4.54) | (-4.71) | (-1.97) | (-1.81) | (-1.41) |
| Depreciation | -0.19 | -0.21 | -0.11 | 0.13 | 0.11 | 0.20 |
| | (-2.71) | (-3.02) | (-1.78) | (1.50) | (1.25) | (2.59) |
| $MTR^1$ | -0.27 | -0.31 | -0.33 | -0.22 | -0.26 | -0.28 |
| | (-11.40) | (-12.86) | (-15.94) | (-7.47) | (-8.85) | (-10.15) |
| Herfindahl | -0.13 | -0.09 | -0.39 | 0.02 | 0.04 | -0.24 |
| | (-1.06) | (-0.76) | (-3.82) | (0.14) | (0.28) | (-1.75) |
| Dividend | -5.77 | -5.98 | -9.53 | -4.97 | -5.02 | -8.60 |
| | (-13.38) | (-13.55) | (-24.90) | (-9.28) | (-9.26) | (-17.07) |
| Asset volatility | | | -0.52 | | | -0.50 |
| | | | (-27.40) | | | (-19.93) |
| Asset beta | | | -7.28 | | | -7.21 |
| | | | (-15.34) | | | (-11.53) |
| Adj. $R^2$ | 0.37 | 0.34 | 0.46 | 0.36 | 0.34 | 0.46 |