Financing decisions when managers are risk averse

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Abstract

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. I find that: (1) the volatility costs of debt can be large for executives exposed to firm-specific risk; (2) for a range of empirically relevant parameters, higher option ownership tends to increase, not decrease, the volatility costs of debt; and (3) for managers with stock options, a stock price increase typically raises volatility costs. For a large sample of US firms, I find evidence that volatility costs affect both the level of and short-term changes in debt, and that volatility costs help explain a firm’s choice between debt and equity.

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1. Introduction

The finance literature has long recognized that firms’ financing decisions can affect managers differently than shareholders. One important difference arises because stock-based compensation exposes managers to firm-specific risk, giving them an incentive to...
keep debt levels low. The goal of this paper is to explore how the firm’s mix of stock and option compensation affects managerial incentives to raise or lower debt, as well as to test whether these incentives help explain observed financing choices for a large sample of US firms.

The first part of the paper explores, from a theoretical perspective, how leverage affects a CEO through its impact on stock volatility. Here, CEO welfare is measured as the certainty equivalent of wealth (CE) in order to account for managerial risk aversion, and the impact of a change in debt is measured by the associated change in CE. I refer to this measure as the CEO’s “financing incentives” or the “volatility costs” of debt. The analysis starts by computing financing incentives for the median CEO in a sample of large US companies. I then vary the portfolio holdings of the manager, relevant firm characteristics, and the CEO’s level of risk aversion and outside wealth to explore how financing incentives depend on various parameters.

The analysis provides several key insights. Most important, I find that the volatility costs of debt to executives can be large, particularly if they hold in-the-money options. Researchers often argue that options, because of their convexity, encourage managerial risk-taking. This reasoning underlies much empirical research on the relation between compensation and leverage (discussed below). However, if managers are risk averse and not well diversified, in-the-money options actually discourage risk-taking and leverage for a wide range of parameters (assuming managers cannot hedge their exposure to a firm’s stock). For example, suppose a CEO with a constant relative risk aversion of two has 90% of his wealth invested in the firm, split between 100,000 shares of stock and 600,000 options with a strike-to-price ratio of 1.3 (the firm’s expected return and variance match their median sample values). His CE drops by 4.9% if leverage increases by ten percentage points, compared with a drop of 1.2% if the CEO owns only shares (no options) with the same market value. Intuitively, in-the-money options make the manager’s portfolio more sensitive to changes in stock price, so they make the manager more averse to stock price volatility. Out-of-the-money options tend to have the opposite effect: they provide protection against price declines, making volatility more attractive to the manager (see, e.g., Haugen and Senbet, 1981; Smith and Stulz, 1985; Smith and Watts, 1992).

Whether options actually make managers more or less conservative is therefore an empirical question. My analysis suggests that, for empirically relevant parameters, options discourage risk-taking and leverage for most firms in my sample. The magnitude of these incentive effects depends on the CEO’s risk aversion and outside wealth, which are generally unknown. 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.)

The theoretical results suggest that stock-based compensation can make debt financing costly to executives. The second part of the paper tests whether these costs influence actual financing decisions for a large cross section of firms. There are at least two reasons to believe that managerial incentives could be important. First, managers might have discretion over a firm’s capital structure because of imperfections in corporate governance. For example, the board of directors might fail to adequately represent shareholder 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 and it is costly to perfectly align managers’ incentives with those of shareholders. Optimally, it would be useful to distinguish between these hypotheses, but the goal of this paper is more modest: to test whether managerial incentives help explain observed financing choices.

To investigate these issues, I estimate financing incentives for 1,587 large US companies during the period 1993–2001. For each firm, I collect detailed compensation data from Standard & Poor’s ExecuComp database, allowing me to reconstruct CEOs’ portfolios in each year. Using this information, I estimate financing incentives under various assumptions about CEO risk aversion and outside wealth, again measuring financing incentives as the impact of a change in leverage on CE. I use these estimates to test, in several ways, whether managerial incentives help explain both time-series and cross-sectional variation in financing choices.

The first set of tests focuses on firms that issue debt or equity in a given year. I find that, conditional on the decision to raise outside funds, firms whose CEOs have stronger incentives to decrease leverage are more likely to issue equity than debt. The results remain significant when the regressions include factors that are correlated with financing incentives, like executive ownership, firm value, and stock volatility, as well as other variables that are known to be associated with debt-equity decisions. My second set of tests asks whether executives who experience an increase in volatility costs are more or less likely to subsequently increase leverage. These tests regress debt changes on lagged changes in incentives and other determinants of debt. The results provide additional evidence that managerial incentives 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 ratio. To avoid a reverse-causality problem, I estimate financing incentives in the absence of leverage, rather than for the firm’s actual leverage. The regression results are again consistent with earlier tests. Overall, the evidence suggests that managerial incentives have an economically meaningful impact on financing decisions.

This study is not the first to explore the relation between leverage and compensation, but prior research has not tried to quantify financing incentives, focusing instead simply 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 et al. (1990) show that stock volatility increases after the approval of stock option plans; Mehran (1992) finds a positive relation between option holdings and leverage; and Tufano (1996) finds a negative relation between option holdings and hedging activities. These studies argue that incentive compensation encourages risk-taking and higher leverage, contrary to my theoretical results. The tests reported in this paper provide some evidence that option ownership is positively associated with leverage, but my analysis points towards alternative explanations, unrelated to managers’ risk incentives (see, e.g., Berger et al., 1997). In related work, Guay (1999), Cohen et al. (2000), Rajgopal and Shevlin (2002), Knopf et al. (2002), and Coles et al. (2006) analyze managerial risk incentives using the Black-Scholes model to value options. My results show that this approach can be misleading when applied to undiversified, risk-averse executives.

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1Friend and Lang (1988) and Agrawal and Nagarajan (1990) find the opposite, but both papers consider managerial stock ownership only, rather than stock and option ownership.
A few recent studies do take into account managerial 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; Hall and Murphy, 2002). Three exceptions are noteworthy: Lambert et al. (1991) point out that, when executives are risk averse, options can either encourage or discourage risk-taking; Ross (2004) describes general conditions under which incentive schedules make managers more or less risk averse; and Carpenter (2000) 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 papers are consistent with mine, but they do not analyze executives’ leverage choices or risk incentives for actual firms, or test their models empirically.

The paper is organized as follows. Section 2 explores the impact of financing decisions on risk-averse managers. Section 3 describes the data and provides descriptive evidence on financing incentives. Section 4 discusses the empirical results. Section 5 concludes.

2. How do leverage changes affect executives?

CEOs and other top managers are typically undiversified, holding significant stakes in their own firms. Although they can hedge this exposure to some degree, managers face many restrictions on hedging: stock holdings might be restricted, executive stock options are non-transferable and subject to vesting restrictions, and the SEC prohibits executives from shorting their own stock. Moreover, managers face various implicit and explicit constraints on sales of so-called non-restricted stock. As a result, it is likely that a typical manager perceives the firm’s risk differently than well-diversified shareholders. This section explores how stock-based compensation affects a manager’s preference for stock volatility and leverage.

2.1. Measuring financing incentives

The basic approach for measuring financing incentives is straightforward. Because I am interested in the incentives induced by a given compensation scheme, I take the CEO’s portfolio holdings as given and ask how a change in leverage affects the certainty equivalent of the CEO’s wealth through its impact on the mean and variance of stock returns. This approach assumes that managers cannot hedge the additional risk resulting from the leverage change; allowing some hedging would mitigate the negative incentive effects.

The main text of the paper reports numerical simulations because, given the assumptions below, there do not exist simple closed-form expressions for the results. Appendix A provides more general analytical expressions, using an approach suggested by Ross (2004). The two approaches are complementary. The numerical analysis gives us a better understanding of the directions and magnitudes of financing incentives for typical firms. Appendix A provides intuition regarding 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. While I have information about most relevant parameters, such as the

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2These constraints include ownership requirements and trading restrictions imposed by firms (Bettis et al., 2000; Cai and Vijh, 2006), as well as SEC restrictions on insider sales (Kahl et al., 2003). In addition, executives could find it costly to sell unrestricted stock because of concerns with signaling or voting control.
composition of the CEO’s portfolio and the firm’s stock volatility, two important inputs are 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 power utility function that is widely used in the literature because of its appealing properties (specifically, it exhibits constant relative risk aversion, CRRA) and report results for a wide range of risk-aversion parameters and outside-wealth assumptions. Second, I show analytically in Appendix A that the qualitative conclusions are fairly general and apply for other concave utility functions.

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 manager’s actual portfolio, i.e., CE is the dollar amount that satisfies

\[ U(CE) = E[U(\tilde{W})], \]  

(1)

where \( \tilde{W} \) is the CEO’s random end-of-period wealth and \( U(\cdot) \) is his utility function. The impact of a change in leverage from \( L_0 \) to \( L_1 \) on CEO welfare is simply the associated change in CE, which is my measure of financing incentives. I denote this measure as \( FI = CE(L_1) - CE(L_0) \).

The CEO has power utility with risk aversion parameter \( \gamma \) (again, Appendix A discusses results for alternative utility functions):

\[ U(W) = \frac{1}{1 - \gamma} W^{(1-\gamma)}. \]  

(2)

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. At the end of the holding period \( T \), the CEO liquidates his entire portfolio. His end-of-period wealth is

\[ \tilde{W}_T = \text{Shares} \cdot \tilde{P}_T + \sum_{i=1}^{n} \text{Options}_i \cdot \max(0, \tilde{P}_T - X_i) + \text{T-bills}_T, \]  

(3)

where \( P_T \) is the end-of-period stock price, Shares is the number of shares held, and Options\(_i\) is the number of options with exercise price \( X_i \). The reported 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 and when T-bills are replaced by the market portfolio (these robustness checks are not reported).

The simulations assume that stock returns, \( 1 + \tilde{R} \), 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 the capital asset pricing model (CAPM). In the benchmark example in Section 2.2, the initial standard deviation and beta correspond to the median firm in my sample.

A change in 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

\[ \theta^1 = r + \frac{[(1-L^0)/(1-L^1)](\theta - r)}, \]

where \( r \) is the risk-free rate, and the standard deviation is \( \lambda^1 = \frac{[(1-L^0)/(1-L^1)]\lambda}. \) This basic model should work well for firms with relatively safe debt but might not be appropriate for
highly levered firms. As a robustness test, Appendix B 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.

FI 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 impact on expected bankruptcy costs, taxes, or agency costs (but subsequent empirical tests do control for these factors).

2.2. Numerical results

The benchmark simulations are based on the median firm in my sample (the sample is described in Section 3). Starting from this benchmark, 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 median firm in the sample (Table 4, discussed later, shows the distribution of parameters for the sample firms). The benchmark firm has asset volatility of 28%, an 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, 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 results, Fig. 1 compares incentives induced by stock and options for the representative CEO. Financing incentives are defined as the 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, and the portfolio is then varied along two dimensions. First, I vary the number of options between zero and 600,000—illustrated by different curves in the graph—and adjust the number of shares to keep the portfolio value constant (options are valued using Black-Scholes). Second, I vary the exercise price—moving along each curve—and adjust the number of shares, options, and outside wealth proportionally to keep the portfolio value constant.4 Fig. 1 assumes that the CEO has a risk-aversion coefficient of two and has

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3The 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; when I repeat the analysis assuming a 1% leverage increase, the incentives are roughly one-tenth those reported in Fig. 1.

4I multiply the number of shares, options, and T-bills by the same factor, so the total value of each changes as the exercise price changes. Because I use CRRA utility, the scaling factor does not affect the results. The qualitative results are similar when I adjust only the number of options in the portfolio to keep the value of each component constant along the curves.
outside wealth, invested in T-bills, corresponding to 10% of the stock and option portfolio value. Thus, the example shows financing incentives for an undiversified CEO whose wealth is invested heavily in the firm. I later show results for a range of assumptions about risk aversion and outside wealth.

Fig. 1 reveals several striking results. First, options decrease managerial preference for leverage and risk over a wide range of exercise prices. In the figure, incentives are negative when options are in the money, and are strongest between strike prices of $15 and $35 (the stock price is $40). Second, in-the-money options seem to discourage risk-taking more than shares. When options are in the money, FI is strongest (and negative) when the CEO’s portfolio consists mostly of options, and FI is weakest when the CEO holds mainly shares of the same value. Third, the direction of the incentive effects is reversed for out-of-the-money options. In this region, replacing shares with options increases the CEO’s preference for debt.

Stock options protect the manager from price declines, so it is intuitive that out-of-the-money options in Fig. 1 tend to encourage risk-taking. It is perhaps less obvious why the effect reverses for in-the-money options. To understand this, note that replacing shares with in-the-money options makes the CEO’s portfolio more levered in the stock, in the sense that a given change in stock price has a larger impact on the portfolio value. The implication is that such options magnify risk, making the CEO more averse to stock volatility.
Fig. 2 provides an alternative way to look at these effects by comparing utility from an all-stock portfolio (dark solid line) and a portfolio consisting of both options and shares (light solid line). Utility is measured as a function of the end-of-period stock price, rather than wealth, so the concavity of the function directly measures the CEO’s attitude towards stock volatility. The graph illustrates that options cause a kink in the utility function. The function becomes convex in the region close to the kink, suggesting that options could increase the CEO’s preference for volatility. However, options also magnify concavity in the area to the right of the kink, when the options are in the money. Overall, options could either increase or decrease a CEO’s volatility aversion: they make the utility function more convex in one region but more concave in another. Table 1 shows that the magnification effect dominates for the median CEO portfolio and a wide range of risk-aversion and outside-wealth assumptions.

All examples in this section, including Fig. 2, use power utility, and an obvious question is whether the basic conclusions are valid for alternative utility functions. Appendix A addresses this issue. Using an approach similar to Ross (2004), it shows analytically that the magnification effect dominates for the median CEO portfolio and a wide range of risk-aversion and outside-wealth assumptions.

Let $V(P)$ denote the CEO’s utility as a function of stock price:

\[
V(P) = \frac{1}{1-\gamma} [\text{Shares} \cdot P + \text{Options} \cdot \max[0,(P-X)]]^{1-\gamma}.
\]

(i)

The concavity of $V(P)$ can be measure as $-\frac{V''(P)}{V'(P)} \cdot P$, which corresponds to the definition of the relative risk aversion (RRA) for $V(P)$. (The argument is similar to the absolute risk aversion.) RRA equals $\gamma$ for $P<X$ (i.e., to the left of the kink), and it equals $\gamma/(1-c)$ for $P>X$, where $c = X \cdot \text{Options}/P \cdot (\text{Shares} + \text{Options})$. The parameter $c$ is between zero and one, so it is clear that $\gamma/(1-c)$ is larger than $\gamma$. Note also that RRA equals $\gamma$ for any all-stock portfolio. For example, in Fig. 2 at $P = $40, RRA equals 8.25 for the stock-and-option portfolio, and it equals 3.00 for the all-stock portfolio.
Table 1
Financing incentives for different assumptions about CEO portfolio and risk aversion.

Financing incentives are measured as the percentage change in the certainty equivalent of CEO wealth caused by a ten-percentage-point leverage increase. The CEO holds shares, stock options, and T-bills. In the benchmark case, the CEO holds 200,000 options and 216,000 shares, so that the ratio of the number of options to the number of shares is close to the sample median. Starting from this benchmark, I vary the number of options between 600,000 (“High”) and zero, and adjust the number of shares to keep the value of the stock and option portfolio constant (options are valued using Black-Scholes). The amount of T-bills is expressed as a percent of the stock and option portfolio value. The CEO has a CRRA utility function with a risk-aversion coefficient varying from 2 to 5. Stock price = $40; exercise price = $30; asset volatility = 28%; asset beta = 0.7; market leverage = 15%; portfolio holding period = 1 year.

<table>
<thead>
<tr>
<th>Risk aversion</th>
<th>Fraction of options</th>
<th>T-bills as a percent of stock and option portfolio value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0%  10%  20%  30%  40%  50%  60%  70%  80%  90%  100%  200%</td>
</tr>
<tr>
<td>5</td>
<td>High</td>
<td>-9.57  -7.01  -5.83  -5.03  -4.41  -3.91  -3.50  -3.14  -2.84  -2.58  -2.36  -1.10</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>-6.61  -5.00  -4.02  -3.34  -2.83  -2.44  -2.13  -1.88  -1.67  -1.49  -1.34  -0.56</td>
</tr>
<tr>
<td></td>
<td>Zero</td>
<td>-4.74  -3.57  -2.84  -2.33  -1.95  -1.67  -1.44  -1.26  -1.11  -0.99  -0.88  -0.35</td>
</tr>
<tr>
<td>4</td>
<td>High</td>
<td>-10.15  -7.49  -6.07  -5.09  -4.35  -3.77  -3.31  -2.92  -2.60  -2.33  -2.10  -0.89</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>-5.66  -4.30  -3.44  -2.84  -2.39  -2.04  -1.77  -1.55  -1.36  -1.21  -1.08  -0.42</td>
</tr>
<tr>
<td></td>
<td>Zero</td>
<td>-3.68  -2.82  -2.25  -1.85  -1.55  -1.32  -1.14  -0.99  -0.87  -0.77  -0.68  -0.26</td>
</tr>
<tr>
<td>3</td>
<td>High</td>
<td>-10.47  -7.42  -5.74  -4.64  -3.84  -3.25  -2.78  -2.41  -2.11  -1.86  -1.65  -0.61</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>-4.39  -3.33  -2.65  -2.16  -1.80  -1.52  -1.30  -1.13  -0.98  -0.86  -0.76  -0.25</td>
</tr>
<tr>
<td></td>
<td>Zero</td>
<td>-2.62  -2.02  -1.62  -1.33  -1.11  -0.94  -0.80  -0.69  -0.60  -0.53  -0.46  -0.15</td>
</tr>
<tr>
<td>2</td>
<td>High</td>
<td>-8.46  -5.65  -4.18  -3.26  -2.62  -2.15  -1.79  -1.51  -1.29  -1.11  -0.96  -0.24</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>-2.73  -2.06  -1.62  -1.30  -1.06  -0.87  -0.73  -0.61  -0.52  -0.44  -0.37  -0.06</td>
</tr>
<tr>
<td></td>
<td>Zero</td>
<td>-1.54  -1.19  -0.94  -0.76  -0.63  -0.52  -0.43  -0.37  -0.31  -0.26  -0.22  -0.04</td>
</tr>
</tbody>
</table>
It also points out that, in addition to the magnification and convexity effects, an incentive scheme can alter a CEO’s attitude towards risk simply because it makes him more (or less) wealthy. 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 constant relative risk aversion (power utility), the wealth effect is eliminated if we use relative risk aversion as the measure of the manager’s attitude towards risk.

2.2.3. Risk aversion and outside wealth

Most parameters in Fig. 1 are close to their sample medians, but two parameters—the CEO’s risk aversion and outside wealth are unobservable. Fig. 3 and Table 1 show estimates for a range of assumptions. Fig. 3 depicts incentives for risk-aversion coefficients of two and three and for outside wealth of either 10% or 100% of the stock and option portfolio value (the benchmark portfolio again consists of 216,000 shares and 200,000 options). Table 1 considers additional scenarios.

The figure shows that higher fractions of T-bills or lower risk-aversion coefficients lead to less negative incentive estimates for all considered portfolios. But importantly, all curves

![Figure 3: Financing incentives for different assumptions about risk aversion and outside wealth. Financing incentives are measured as the percentage change in the certainty equivalent (CE) of CEO wealth caused by a ten-percentage-point leverage increase. The base case stock and option portfolios consist of 200,000 options with a strike price of $30, 216,000 shares, and T-bills equal to 10% or 100% of the stock and option value. Along each curve, I vary the strike price and adjust the number of shares, options, and T-bills proportionally to keep the portfolio value constant. The stock portfolios are 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. The CEO has a CRRA utility function with a risk-aversion parameter of 2 or 3. Stock price = $40; asset volatility = 28%; asset beta = 0.7; market leverage = 15%; portfolio holding period = 1 year.](image-url)
in Fig. 3 representing stock and option portfolios have the same basic shape as in Fig. 1, and financing incentives remain negative if options are sufficiently in the money. As in Fig. 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, the thin lines in Fig. 3 show financing incentives created by all-share 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. The figure shows that when options are in the money, these all-share portfolios tend to cause less negative incentives than the corresponding stock and option portfolios.

2.2.4. Black-Scholes vs. the certainty equivalent approach

My results contradict the common intuition 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 certainty-equivalent and Black-Scholes approaches. Black-Scholes assumes that managers can trade freely. Option value is independent of preferences either because investors are well diversified or can dynamically hedge the option. The CE approach assumes, instead, that a significant fraction of executives’ wealth is tied to firm performance and that executives cannot hedge portfolio risk. In reality, managers can probably hedge to some extent, so both approaches make simplifying assumptions.

The Black-Scholes and CE approaches 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 are not a good 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. Fig. 4 explores how financing incentives depend on asset volatility and market leverage. It focuses on a CEO with in-the-money options, similar to the median CEO (as before, different curves represent portfolios with different proportions of stock and options), and I again assume a risk-aversion coefficient of two and outside wealth of 10%. The analysis shows that financing incentives vary strongly with firm characteristics. The common pattern is that managers become more averse to leverage when asset volatility and market leverage increase. The direction of these effects is robust to the considered risk-aversion and outside-wealth assumptions (not reported).

The first two panels of Fig. 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 stock price increase might substantially reduce the CEO’s preference for debt as options become somewhat in the money. In contrast, static tradeoff theory predicts that shareholders will prefer more debt if 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 can induce, at least temporarily, a divergence between stockholders’ and managerial incentives to raise debt.

Fig. 4. The effects of volatility, leverage, and stock price on financing incentives. Financing incentives are measured as the percentage change in the certainty equivalent (CE) of CEO wealth caused by a ten-percentage-point 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 = 1 year; the CEO’s portfolio = 200,000 options, 216,000 shares, and T-bills equal to 10% of the stock and option value. In each figure, starting from the base case I vary the number of options between zero and 600,000, and adjust the number of shares to keep the value of the portfolio constant. Thus, each curve represents different proportion of shares and options. In the first two figures, I vary asset volatility (leverage) along each curve holding all other parameters constant. In the last figure, I vary the stock price along each curve and adjust leverage to reflect the stock price change.
2.3. Summary

The key results from the numerical analysis are as follows: (1) when managers are risk averse and constrained from hedging, in-the-money stock options can 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; and (3) Black-Scholes and CE approaches to analyze risk incentives disagree not only about the direction and magnitudes of incentives, but also about how incentives vary across firms.

3. Data, sample selection, and descriptive statistics

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

3.1. Data

The data on CEO stock and option ownership come from Standard & Poor’s ExecuComp database. I also use accounting data from Compustat, stock data from the Center for Research in Security Prices (CRSP), and marginal tax rate estimates provided by John Graham (http://www.duke.edu/~jgraham). The ExecuComp database covers 2,502 large US firms from 1992 through 2001. The SEC has required detailed disclosure on executive compensation for fiscal years ending after December 15, 1992, and the ExecuComp database is virtually complete starting in 1993. The database contains the numbers of shares, restricted shares, and options that are owned each year for each CEO. 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 (2002) that relies on detailed information about current and past option grants. The algorithm assumes that the CEO always exercises the “oldest” grants first. Therefore, his portfolio in any given year consists of the grants awarded in more 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 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 were exercised at the
end of the fiscal year. The average exercise price of unexercisable options in a given fiscal year is approximated as the closing price for the fiscal year less the ratio of the realizable value and the 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.

3.2. Sample selection

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. 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 observations for which the estimated exercise price is negative. This procedure reduces the sample by 1,416 firm-years.

The computation of incentives requires estimates of stock volatility, market beta, and financial leverage. Merging 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 for which the CEO has no stock or options, and 18 observations with market leverage higher than 90% (because incentive effects associated with a ten-percentage-point leverage increase are not defined for such firms). The final sample, with data available for all control variables described later, consists of 1,587 firms (7,255 firm-years) for the debt level regressions and 1,504 firms (6,333 firm-years) 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.

3.3. Descriptive statistics

Descriptive statistics for the sample are presented in Table 2 and a correlation matrix for the variables is shown in Table 3. The tables include variable definitions. The sample represents about 14% of all nonfinancial non-utility firms on Compustat during the 1993–2001 period. The average firm is large, with book assets equal to $3.9 billion (median, $0.9 billion) and a market value equal to $8.3 billion (median, $1.6 billion). For comparison, the average nonfinancial, non-utility firm on Compustat has book assets of $1.6 billion (median, $86 million) and a market value of $2.8 billion (median, $155 million).

I use several proxies for growth options: the market-to-book (M/B) ratio, R&D expense as a percent of total assets, and property, plant, and equipment (PP&E) plus inventories as a 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, average M/B
for the sample is 4.9 compared with a mean of 6.4 for all Compustat firms. However, median M/B 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, 32%) compared to 31% (median, 27%) for the average Compustat firm.

The bottom part of Table 2 describes CEO wealth and wealth composition. The average CEO owns 3.5% of his company’s common stock (median, 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 as a percent of shares outstanding, are also positively skewed with a mean of 1.1%, median of 0.6%, and 99th 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 (mean, $114 million). The sample includes CEOs like Bill Gates in 1999 and Michael Dell
Table 3
Correlation matrix for a sample of 7,255 firm-years (1,587 firms) from 1993 to 2001.

BOOK ASSETS ($ bil.) is book value of total assets. b($ bil.) = book assets – book value of common stock + market value of common stock. M/B is the ratio of the market value to the book value of common stock. R&D is R&D expense as a percent of total assets. PPE is PP&E plus inventory as a percent of total assets. DIVIDEND is a dummy variable equal to one if the firm pays dividends. BOOK (MARKET) LEVERAGE is total debt as a percent of the sum of total debt and the book (market) value of common stock. VOLATILITY (%) is the annualized standard deviation of stock returns computed from weekly returns over three years. STOCK RETURN (%) is the one-year stock return. ROA is net income as a percent of total assets. SHARES (OPTIONS) is the number of the CEO’s shares (options) as a percent of shares outstanding. WEALTH ($ mil.) is the dollar value of the CEO’s stock and option portfolio. OPTIONS VALUE ($ mil.) is the Black-Scholes value of the CEO option portfolio. FI are financing incentives.

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<td>1.00</td>
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<td>-0.58</td>
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<td>0.14</td>
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<td>0.08</td>
<td>0.28</td>
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<td>Stock return</td>
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<td>0.03</td>
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<td>ROA</td>
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<td>0.14</td>
<td>-0.24</td>
<td>-0.18</td>
<td>-0.26</td>
<td>0.12</td>
<td>1.00</td>
<td>0.07</td>
<td>-0.18</td>
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<td>0.06</td>
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<td>Shares</td>
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<td>-0.07</td>
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<td>-0.09</td>
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<td>0.07</td>
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<td>-0.01</td>
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<td>Options</td>
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<td>-0.02</td>
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<td>Wealth</td>
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<tr>
<td>Options value</td>
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<td>-0.04</td>
<td>-0.11</td>
<td>-0.03</td>
<td>0.06</td>
<td>0.16</td>
<td>0.06</td>
<td>0.01</td>
<td>0.08</td>
<td>0.18</td>
<td>1.00</td>
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in 1998 with total wealth of $70 billion and $19 billion, respectively. On average, options constitute about 37% of CEO portfolio value (median, 31%).

### 3.4. Financing incentives– descriptive evidence

Table 4 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 ten percentage points. I show estimates for different assumptions about risk aversion and

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**Table 4**

Descriptive statistics for financing incentives for 7,255 firm-years (1,587 firms) from 1993 to 2001.

Financing incentives are measured as the percentage change in the certainty equivalent of CEO wealth caused by a ten-percentage-point leverage increase. I assume that the CEO has a CRRA utility and that his outside wealth is invested in T-bills. I make different assumptions about the risk-aversion coefficient (RISK AV) and the amount of T-bills as a percent of the stock and option portfolio value (TB). MARKET LEVERAGE is total debt as a percent of the sum of total debt and the market value of common stock. ASSET BETA (ASSET VOLATILITY) is stock beta (annualized standard deviation of stock returns) times 1-market leverage/100. Volatility and beta are computed from weekly returns over three years. SHARES RATIO is the number of shares as a percent of the number of shares and options owned by the CEO. 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. WEALTH ($ mil.) is the value of the CEO’s stock and option portfolio.

**Panel A: Descriptive statistics for financing incentives estimated under different assumptions**

<table>
<thead>
<tr>
<th>Risk av., TB</th>
<th>Mean</th>
<th>Std</th>
<th>P1</th>
<th>Median</th>
<th>P99</th>
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<td>2,100</td>
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<td>-3.31</td>
<td>-0.36</td>
<td>1.31</td>
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<tr>
<td>3,100</td>
<td>-1.04</td>
<td>1.34</td>
<td>-5.32</td>
<td>-0.82</td>
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</table>

**Panel B: Correlation table for financing incentives estimated under different assumptions**

<table>
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<tr>
<th>Risk av., TB</th>
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<th>3,10</th>
<th>2,100</th>
<th>3,100</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,10</td>
<td>1.00</td>
<td>0.90</td>
<td>0.98</td>
<td>0.97</td>
</tr>
<tr>
<td>3,10</td>
<td>0.90</td>
<td>1.00</td>
<td>0.87</td>
<td>0.96</td>
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<tr>
<td>2,100</td>
<td>0.98</td>
<td>0.87</td>
<td>1.00</td>
<td>0.96</td>
</tr>
<tr>
<td>3,100</td>
<td>0.97</td>
<td>0.96</td>
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**Panel C: Descriptive statistics for the parameters used to estimate financing incentives**

<table>
<thead>
<tr>
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<th>Mean</th>
<th>Std</th>
<th>P1</th>
<th>Median</th>
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</tr>
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<td>Asset beta</td>
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<td>Market leverage</td>
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<td>18.65</td>
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<td>14.98</td>
<td>75.54</td>
</tr>
<tr>
<td>Shares ratio</td>
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<td>34.38</td>
<td>0.00</td>
<td>43.04</td>
<td>100.00</td>
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<tr>
<td>Price/strike</td>
<td>1.94</td>
<td>2.98</td>
<td>0.37</td>
<td>1.33</td>
<td>11.56</td>
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<td>Wealth</td>
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outside wealth, which affect the magnitude but not the cross-sectional pattern of the estimates. For a risk-aversion coefficient of three, the mean estimates vary from –5.12% to –1.04% as T-bills change from 10% to 100% of the stock and option value. The correlations among the estimates for different risk-aversion and outside-wealth assumptions are quite high, ranging from 87% to 98%. Because the correlations are so high, the empirical tests in Section 4 are robust to different assumptions about risk aversion and outside wealth. To save space, I present only results based on a risk aversion of three and outside wealth of 10%.

Table 4 reveals considerable variation in volatility costs across firms. For example, for a risk aversion of three and outside wealth of 10%, financing incentives range from –22.45% (1st percentile) to –0.40% (99th percentile), with a mean of –5.12%. Interestingly, the estimates are negative for most CEOs in my sample, even assuming outside wealth of 100% and a risk aversion of two. The numerical analysis in Section 2 shows that volatility costs are determined by several firm and portfolio characteristics. In particular, I expect that incentives are lower for CEOs with higher option ownership, provided that the options are sufficiently in the money, and for firms with higher stock return volatility and leverage (see, in particular, Fig. 4 in Section 2). Consistent with these results, the correlation matrix in Table 3 shows that incentives are negatively correlated with CEO option ownership (measured as a percentage of shares outstanding) and also with volatility and leverage. In addition, Fig. 4 in Section 2 shows that higher stock returns could increase volatility costs by making the stock options more in the money, but that the effect reverses for higher price-to-strike ratios. Perhaps because of this ambiguous effect, the correlation between incentives and stock returns, reported in Table 3, is small and statistically not significant.

To illustrate the cross-sectional patterns, the following examples compare representative firms whose financing incentives are close to the 10th or the 90th percentile of the sample distribution. Whirlpool Corp.’s CEO in 1994 has relatively low volatility costs, with FI equal to –1.5% compared with the sample median of –4.1% when risk aversion is three and outside wealth is 10%. Consistent with the analysis in Section 2, Whirlpool’s CEO owns relatively few stock options relative to shares. More precisely, the ratio of the number of shares to the number of shares and options in his portfolio (“shares ratio”) is 62% compared to the sample median of 43%. The options are only weakly in the money (the price-to-strike ratio is 1.1 compared to the median of 1.3), and Whirlpool’s volatility is relatively low (e.g., asset volatility is 17% compared to the median of 28%). These parameters tend to reduce a manager’s aversion to leverage (i.e., they make FI closer to zero). Whirlpool’s above-median leverage of 35% (the median is 14%) likely has the opposite effect, but the effect is not strong enough to push FI above the sample median.

In comparison, Bausch & Lomb’s CEO in 1998 has high volatility costs of –8.2%, close to the 10th percentile of the sample distribution. Not surprisingly, Bausch & Lomb’s CEO’s portfolio is weighted much more heavily toward options (shares ratio is only 14%), and the options are more in the money (price-to-strike ratio is 1.5) compared to Whirlpool. The two firms have similar stock and asset volatility and similar leverage, so the difference in incentives is driven primarily by the CEO portfolio composition (Bausch & Lomb’s asset volatility is 18% and market leverage is 30%). Alternatively, consider Apache Corp in 2001. Apache’s CEO owns fewer stock options (shares ratio is 43%), yet volatility costs are relatively high (FI = –7.2%). In this case, above-median stock and asset volatility contribute to the stronger aversion to leverage. (Apache’s asset volatility is 36%, market
leverage is 25%, and the options’ price-to-strike ratio is 1.5.) In short, the magnitude of volatility costs reflects an interaction among several firm and portfolio characteristics, as discussed in Section 2. The tests below control for each of these parameters to make sure that none of them individually drives the results.

4. Do managerial incentives affect financing policy?

The numerical analysis shows that stock-based compensation can make debt financing costly to managers. This section tests whether managers’ private costs affect actual financing decisions. As discussed earlier, this can happen if managers choose a firm’s capital structure and their decisions are not perfectly monitored by shareholders.

I use three different approaches to address this question. First, I test whether, conditional on the decision to raise outside funds, managers with stronger incentives to reduce leverage are less likely to issue debt than equity. Second, I test whether changes in a manager’s financing incentives help explain future changes in leverage. Third, I test whether financing incentives help explain cross-sectional variation in debt levels. All three sets of regressions support the hypothesis that managers’ volatility costs affect financing decisions.

4.1. Debt-equity choice

The first set of tests is based on a probit model of debt-equity choice, similar to Marsh (1982), MacKie-Mason (1990), Jung et al. (1996), and Hovakimian et al. (2001). These studies analyze how firms that decide to raise outside funds choose between different financing instruments. The literature identifies a number of relevant factors (discussed below), consistent with both the tradeoff and pecking order theories of capital structure. My paper tests whether, controlling for these factors, managers’ volatility costs of debt have an incremental impact on the debt-equity choice.

4.1.1. Determinants of debt-equity choice

It is critical that my tests control for other determinants of the debt-equity choice, suggested by the theory and prior evidence. According to the classic version of the tradeoff theory, firms choose their optimal leverage by trading off the tax benefits of debt against the costs of financial distress (Modigliani and Miller, 1963). The theory suggests that, in the presence of adjustment costs, the actual leverage ratio could temporarily deviate from the “optimal” level but that a firm should periodically readjust its capital structure towards the long-term target (e.g., Fischer et al., 1989; Leland, 1998). In particular, a firm in need of external finance should issue equity if its leverage ratio is above the target and issue debt if it is below. Following this reasoning, I include both the actual leverage and a proxy for the long-term target as control variables in the probit model. I estimate the target proxy as fitted values from a leverage level regression (see, e.g., Hovakimian et al. 2001; Fama and French, 2002). The target regression reflects the standard arguments of the tradeoff model and is described in Section 4.3.4.

Although prior evidence on the debt-equity choice is generally consistent with the tradeoff theory, several well-documented patterns point towards alternative hypotheses. For example, many studies find that firms are more likely to issue equity when their market
values are high relative to book values and past market values. This finding is consistent with a number of explanations. For example, it is possible that managers issue equity when they believe that it is overvalued. Alternatively, firms could choose equity over debt when information asymmetries decline or when investment opportunities improve, thereby reducing potential free cash flow problems. To account for these effects, the probit regressions in Table 5 include the lagged market-to-book ratio and the prior-year stock return as control variables.

Another well-documented finding is that the likelihood of a debt issue increases with past profitability (see, e.g., Hovakimian et al., 2001; Hovakimian, 2004). One explanation, suggested in the literature, is that profitable firms tend to accumulate earnings and, thus, become temporarily underlevered. Consequently, they choose debt over equity in years when they need to raise new funds. Alternatively, it is possible that profitability proxies for the value of assets in place (and, indirectly, debt capacity), and this effect is not captured by the noisy measure of target leverage. For these reasons, I include the prior-year return on assets (ROA) in addition to the target leverage, as a control variable in the probit model. Finally, I control for issue size because prior literature shows that issue size is positively associated with debt issues (e.g., Jung et al., 1996). Issue size and the type of security issued are likely simultaneously determined, so the sign of the coefficient on issue size is ambiguous.

In addition to the standard factors used in most prior studies, the probit model in Table 5 includes three additional control variables: stock return volatility, executive stock ownership, and executive option ownership before the issue. These variables are correlated with financing incentives but could have independent effects on the debt-equity choice. First, firms with high stock return volatility could face a higher probability of financial distress, and thus avoid additional debt issues. Second, executive stock and option ownership could proxy for various agency conflicts within the firm, independent of the effect on volatility costs. I discuss the interdependence between financing incentives and executive ownership in Section 4.1.3 below.

### 4.1.2. 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 issuance in that year (i.e., debt issued minus debt retired) exceeds 1% of total assets. Similarly, an equity issuer is a firm with net equity issuance (i.e., equity issued minus equity repurchased) higher than 1% of total assets. The results are similar when the cutoffs are 2% or 3%. The sample consists of 2,273 firm-years (1,026 firms) classified as debt issuers and 1,208 firm-years (705 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 2. 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

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7See, for example, Asquith and Mullins (1986), Mikkelson and Partch (1986), Jung et al. (1996), Hovakimian et al. (2001), and Baker and Wurgler (2002).

8The information asymmetries hypothesis is consistent with Myers and Majluf (1984) and with dynamic pecking order models such as Lucas and McDonald (1990) and Korajczyk et al. (1992). Stulz (1990) and Jung et al. (1996) suggest the free cash flow explanation.
Table 5
Probit model of debt-equity issue choice for 3,481 firm-years (1,433 firms) from 1993 to 2001.

The model estimates the probability of a debt issue. All variables are for the fiscal year preceding the issue. FI are financing incentives. SHARES (OPTIONS) is the number of the CEO’s shares (options) as a percent of shares outstanding. In Columns 1-4, TARGET is the fitted value from a leverage regression (see Section 4.3.4). In Column 5, the fitted value is replaced by the independent variables from the leverage regression. VOLATILITY (%) is the annualized standard deviation of stock returns computed from weekly returns over past three years. STOCK RETURN (%) is the past-year stock return. M/B is the ratio of the market value to the book value of common stock. ISSUE SIZE is measured as a percent of the market value of common stock. All regressions, except in Column 2, include industry dummies; all panel regressions include year dummies. T-statistics are in parentheses. Fama-MacBeth t-statistics are in italics.

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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 ten-percentage-point leverage increase causes a wealth decline of 5.7 percentage points for an equity issuer’s CEO and a wealth decline of 4.7 percentage points for a debt issuer’s CEO.

4.1.3. Results

The probit model is reported in Table 5. 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 4.7 to 10.7. 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 for the yearly coefficients. The t-statistics, ranging from 3.8 to 7.1, confirm statistical significance at a 1% level in all regressions. The impact of volatility costs on issue choice is economically significant. Increasing volatility costs by one standard deviation decreases the probability of a debt issue by 4.3–6.2 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 not significant based on Fama-MacBeth t-statistics. The positive coefficient is consistent with the findings of Mehran (1992) and Berger et al. (1997). One of the interpretations offered in the literature is that options induce risk-taking incentives and create a 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. In fact, my estimates suggest that option ownership is actually negatively correlated with financing incentives (the correlation coefficient in Table 3 is –17%).

There are several alternative explanations for the positive association between option ownership and debt issues. For example, Berger et al. (1997) suggest that higher option ownership indicates a 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; Stulz, 1990), we might observe a positive relation between option ownership and leverage. Another explanation is that performance-based compensation and debt are employed as alternative means to control agency conflicts between managers and shareholders. This endogenous relation could be responsible for a positive coefficient on option ownership, and I discuss this possibility in more detail in Section 4.5.

The coefficients on other control variables are generally consistent with capital structure theories and similar to previous studies. I find that firms are more likely to issue debt than equity if they are more profitable, have lower prior-year stock returns and market-to-book ratios, and lower stock return volatility. The puzzling result in Table 5 is that firms with higher leverage tend to finance their investments with debt rather than equity, even after controlling for target leverage. This result is inconsistent with the tradeoff theory, and it is possible that my proxy for target leverage does not capture the actual target. Below, I perform several robustness tests to explore this possibility.
4.1.4. Robustness tests

In unreported regressions, I replace the “fitted-values” target estimates by simple industry averages. I also experiment with different explanatory variables in the target regression. For example, I exclude M/B from the fitted-value regression because it could capture market-timing motives for debt or equity issues rather than a determinant of long-term target leverage. None of these changes significantly affects the coefficient on target leverage or on incentives. To explore whether the positive coefficient on leverage is specific to my sample, I estimate the probit model for different sample periods and for a broader sample of Compustat firms (excluding the CEO ownership and incentive variables which are not available for the larger sample). I find that the coefficient on leverage is still positive and significant for the broad Compustat sample during my sample period of 1993–2001, so the puzzling result is not specific to the set of firms included in the ExecuComp database. However, the coefficient switches sign when a longer period of 1979–1997 is considered (consistent with Hovakimian et al., 2001). Thus it appears that the target-adjustment model did a better job describing financing behavior during the earlier period than in the recent decade. The last column in Table 5 shows an alternative specification, with target determinants included separately instead of the fitted-values target, similar to MacKie-Mason (1990) and Jung et al. (1996). In addition to the alternative target estimates, I also consider different measures of past returns, market-to-book ratios, and ROA. Following Jung et al. (1996), I include stock returns measured over two or three years before the issue. Similarly, I replace the prior-year M/B and ROA with averages measured over two or three years before the issue, similar to Baker and Wurgler (2002) and Kayhan and Titman (2006). None of these changes has a significant effect on the results.

4.2. 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 tradeoff 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 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 can 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 short-term fluctuations 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 Section 4.3.4). Finally, I include changes in stock and option ownership and stock return volatility, i.e., factors that enter the computation of incentives, as additional control variables.

4.2.1. Results

Table 6 documents a positive and significant association between incentive changes (ΔFI) and subsequent changes in leverage. The panel \( t \)-statistics for the coefficients on ΔFI range from 2.33 to 2.91, and Fama-MacBeth \( t \)-statistics 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, which are directly responsible for shifts in incentives are themselves not associated with subsequent financing decisions.

The coefficients on the control variables are generally similar to those in Fama and French (2002). Consistent with the pecking order theory, I find that firms increase debt when they invest more and when they are less profitable: in all regressions, debt changes are positively associated with contemporaneous changes in assets and negatively associated with contemporaneous changes in profits. Similar to Fama and French, there is also a lagged negative response of debt to earnings, suggesting that capital structure adjusts slowly to changes in profitability. Finally, it appears that some of the leverage increase induced by investment this year is reversed in the subsequent year: in three out of the four regressions, debt changes are negatively and significantly associated with lagged changes in assets. This last finding is consistent with firms adjusting their leverage ratios toward long-term targets.

In contrast to Fama and French, however, I find only weak support for the target-adjustment model. When actual and target leverage ratios are included separately, the coefficient on actual leverage is negative and significant, consistent with target adjustment, but the coefficient on target leverage is insignificant, and in some regressions has the wrong (negative) sign. I obtain a similar result even after excluding variables that could overlap with the target estimate, i.e., incentives, stock and option ownership, volatility, and stock returns (these regressions are not reported). The weak performance of the target-adjustment model during my sample period of 1993–2001 mirrors the analysis of the debt-equity choice model described earlier. The last column in Table 6 includes the variables from the target regression separately, instead of the fitted-value target, but as with the probit model, this change has no significant effect on the coefficients on leverage or on incentives.

4.2.2. Robustness tests

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 ΔFI is positive and significant when the dependent variable is the change in total debt, change in long-term debt, or change in market leverage, it is not significant when the dependent variable is the change in book leverage (only regressions with the 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
Table 6
Debt change regressions for 6,333 firm-years (1,504 firms) from 1993 to 2001.
The dependent variable, $\Delta \text{Debt}_{t+1}$, is the change in debt from year $t$ to $t+1$ scaled by the book value of assets in year $t$. The regressions use $\log(1 + \Delta \text{Debt}_{t+1}) \cdot 100$. Subscript $t$ for changes indicates a change from year $t-1$ to $t$. $\Delta \text{FI}$ is the change in financing incentives. $\Delta \text{SHARES (OPTIONS)}$ is the change in the number of the CEO’s shares (options) as a percent of lagged shares outstanding. $\Delta \text{BOOK ASSETS (\Delta NET INCOME)}$ is the change in the book value of assets (in net income) as a percent of lagged assets. In Columns 1–3, TARGET is the fitted value from a book-leverage regression (see Section 4.3.4). In Column 4, the fitted value is replaced by the independent variables from the regression. VOLATILITY (%) is the annualized standard deviation of stock returns computed from weekly returns over past three years. STOCK RETURN (%) is the past-year stock return. $T$-statistics are in parentheses. Fama-MacBeth $t$-statistics are in italics.

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<td>-0.01</td>
<td>0.02</td>
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<td>(-0.55)</td>
<td>(1.08)</td>
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<tr>
<td></td>
<td>(0.78)</td>
<td>(0.78)</td>
<td>(1.36)</td>
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<td>-0.03</td>
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<td>0.44</td>
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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 B presents an alternative model to estimate financing incentives that assumes that equity is a call option on the firm’s assets. When this alternative model is used, the coefficient on ΔFI in the change regressions is no longer significant. 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 the leverage level regression described next.

4.3. 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.

4.3.1. Measuring incentives for the levels regressions

The tests regress leverage on an estimate of the volatility costs of debt. Volatility costs estimated at the actual leverage level are not appropriate for these regressions because leverage and volatility costs are simultaneously determined (recall the definition of volatility costs, FI, in Section 2.1). For example, an increase in leverage tends to decrease FI through its impact on stock volatility, as shown in Section 2, and a positive shock to FI (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 FI⁰, captures the volatility costs of debt independent of actual leverage (the computation of FI⁰ is similar to FI, 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 robustness 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.

4.3.2. Other determinants of leverage

The regressions include a number of control variables suggested by the tradeoff and pecking order theories of capital structure. According to the tradeoff theory, leverage should be positively related to the tax benefits of debt and negatively related to the expected costs of financial distress. I include depreciation expense as a proxy for non-debt tax shields, and a direct measure of the marginal tax rate (before interest) provided by Graham (1996, 2000). Larger, more diversified, and more profitable firms and firms with less volatile cash flows are less likely to face financial distress. To account for distress probability, I consider the firm’s size, ROA, and earnings volatility. I drop earnings volatility from the reported regressions because it substantially reduces the sample size. Agency conflicts between shareholders and bondholders could contribute to the costs of financial distress by distorting firm’s investment decisions (Myers, 1977; Jensen and Meckling, 1976). Such agency problems are likely more severe for firms with more
investment opportunities, so growth firms should operate at lower leverage. To control for
growth options, I include M/B as well as PP&E plus inventory and R&D expense as a
percent of assets. Finally, bankruptcy could be more costly when the firm’s assets are more
specialized and difficult to liquidate (Titman, 1984). I use advertising expense scaled by
sales, in addition to M/B, PP&E, and R&D, to capture asset uniqueness.

ROA proxies for expected bankruptcy costs, as discussed earlier, but it could also
capture other effects. According to the pecking order theory, profitable firms can finance
their investment with retained earnings and thus avoid issuing debt. Consequently, there
should be a negative relation between leverage and profitability. In contrast, the free cash
flow hypothesis (Jensen, 1986; Stulz, 1990) suggests that profitable firms and firms with less
investment opportunities face more severe free cash flow problems, and should therefore
choose higher debt. Finally, Hennessy and Whited (2005) and Lewellen and Lewellen
(2005) argue that tax considerations could induce firms to retain equity, consistent with a
negative relation between profitability and debt.

To control for other potential determinants of leverage, I include 48 Fama and French
(1997) industry dummies, a measure of industry concentration, and a dummy variable
equal to one if a firm pays dividends. Further, variables that enter the computation of FI⁰
(asset volatility and beta, and stock and option ownership) are included only as control
variables to test if any of them individually drives the association between leverage and
incentives. The control variables are described in more detail in Table 7.

4.3.3. Results

The results for the market leverage regressions are reported in Table 7. Market leverage
is most appropriate to test the importance of volatility costs because market leverage
affects equity risk, although the results are consistent for book leverage. The coefficients on
financing incentives have the predicted positive sign in all specifications. The panel
\( t \)-statistics on FI⁰ vary from 9.5 to 26.6. A one-standard-deviation increase in volatility
costs (FI⁰) is associated with a leverage decline in the range of 1.8 to 5.3 percentage points,
depending on the 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 7 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 follow a first-order autoregressive process. These tests confirm
the statistical significance of financing incentives. For example, in the first column, the
“ordinary” Fama-MacBeth \( t \)-statistic on FI⁰, which assumes zero autocorrelation, is 6.7
(this statistic is not reported in the table). The first-order autocorrelation of the yearly
coefficients is 69%, so the modified Fama-MacBeth \( t \)-statistic reported in the table is 3.4.

It is important to note that my sample estimates of autocorrelations in yearly coefficients are
noisy because the regressions include only nine years of data. I try to mitigate this problem by
estimating market leverage regressions similar to those reported in Table 7 for a sample of
Compustat firms over the period 1979–2001. I have to exclude the incentive and ownership
measures because they are not available for the earlier years of this period. The modified
Fama-MacBeth \( t \)-statistics in Table 7 for all variables, except for the incentive and ownership
measures, are based on autocorrelations estimated from these large-sample regressions.

The coefficients on the control variables are generally consistent with prior studies.
Large firms, firms with fewer growth opportunities, and firms with unique assets have
Table 7
Leverage regressions for 7,255 firm-years (1,587 firms) from 1993 to 2001.

The dependent variable is market leverage (%). FI$^0$ are financing incentives at zero leverage. SHARES (OPTIONS) is the number of the CEO’s shares (options) as a percent of shares outstanding. PPE, R&D, and DEPRECIATION are: PP&E and inventory, R&D expense, and depreciation expense, all as a percent of total assets. M/B is the ratio of the market value to the book value of common stock. BOOK ASSETS ($ bil.) is the book value of total assets. ADVERTISING is advertising expense as a percent of sales. MTR (%) is Graham’s (1996) simulated marginal tax rate before interest expense. HERFINDAHL is Herfindahl index computed based on company sales and 47 Fama and French (1997) industries. DIVIDEND is a dummy variable equal to one if the firm pays dividends. ASSET BETA (ASSET VOLATILITY) is stock beta (annualized standard deviation of stock returns) times 1-market leverage/100. Volatility and beta are computed from weekly returns over past three years. All regressions include industry dummies and year dummies. Panel $t$-statistics and autocorrelation-adjusted Fama-MacBeth $t$-statistics are in parentheses.

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<tr>
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<td>0.46</td>
<td>0.44</td>
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lower leverage. All proxies for expected distress costs have the predicted sign and, except M/B, are statistically significant. Consistent with the pecking order story, profitable firms and firms that pay dividends have lower leverage. There is evidence that non-debt tax shields, i.e., depreciation and R&D, are negatively associated with leverage, but both variables could also measure other things, such as asset tangibility or growth options. Interestingly, the coefficient on Graham’s marginal tax rate is negative and in one specification significantly so, counter to the prediction of tradeoff theory. This variable might proxy for profitability and, consistent with the pecking order theory, the firm’s need for debt financing.

Similar to prior studies and to the evidence from the probit model, I find that leverage is positively associated with option ownership and negatively associated with share ownership (Mehran, 1992; Berger et al., 1997). As discussed earlier, the results are consistent with option ownership capturing managerial entrenchment. It is also possible that performance-based compensation and leverage are employed as alternative means to control agency conflicts between managers and shareholders (Jensen, 1986; Stulz, 1990). Alternatively, leverage and share ownership could be chosen simultaneously by management or other influential shareholders to control voting power (e.g., Stulz, 1988). I discuss these issues in more detail in Section 4.5.

4.3.4. Target leverage

The probit model and the leverage change regressions discussed earlier use a proxy for target leverage estimated as fitted values from a leverage level regression. The target regression is similar to the regressions reported in Table 7, Column 3, except that several explanatory variables are excluded. First, I exclude ROA and Graham’s marginal tax rate before interest. The coefficients on both variables in Table 7 suggest that they capture pecking order effects. Consistent with a pecking order model, I control for profitability separately in both the probit and the leverage change regressions. Second, I exclude variables that are not typically included in the target regressions, and were used in Table 7 primarily to test the robustness of the $FI^0$ coefficient (i.e., ownership measures, asset beta and asset volatility, and $FI^0$ itself).

4.4. Managerial overconfidence and risk tolerance

The analysis presented thus far assumes that executives are, at least to some degree, risk averse. Most empirical evidence is consistent with managerial risk aversion. For example, Huddart and Lang (1996) show that managers tend to exercise stock options long before expiration, sacrificing, on average, 50% of Black-Scholes value; exercise decisions are clustered around vesting dates; and exercise is more likely after stock price run-ups and when volatility is high (see also Carpenter, 1998; and Carpenter and Remmers, 2001). However, Malmendier and Tate (2005) point out that some CEOs hold in-the-money options longer than predicted by a simple diversification story, and a failure to exercise early could, in principle, reflect a manager’s higher tolerance for risk. Alternatively, it is possible that some managers are overconfident about their firms’ prospects, and they choose to forgo diversification benefits in favor of higher expected returns (Malmendier and Tate find evidence supporting the overconfidence story).

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9 Other explanations for delayed exercise are that managers (1) are concerned that early exercise conveys a negative signal to the market; (2) face implicit constraints on early exercise; (3) delay exercise to defer personal taxes on options’ gains; or (4) have positive private information about their firms.
If some managers are indeed risk tolerant or overconfident, one could argue that, for these managers, my estimates of volatility costs of debt are too high. For an overconfident CEO with a “too favorable” estimate of his stock’s expected return, an increase in leverage magnifies the positive bias, which lowers the perceived cost of debt (recall that my estimates of volatility costs assume that the manager’s expected returns are determined by CAPM). Consequently, we should see a weaker or no association between my estimates of volatility costs and financing decisions for this subsample. The additional robustness tests described below try to account for this possibility (the tests are not reported in the tables).

Using an algorithm similar to Malmendier and Tate (2005), I identify a subset of CEOs that fail to exercise in-the-money options. The procedure identifies CEOs that hold exercisable in-the-money options in at least two years during my sample period. Like Malmendier and Tate, I use different cutoffs for in-the-money options (33%, 67%, or 100% in the money). As a first step, I re-run the probit, leverage change, and leverage level regressions for subsamples that exclude these “holder” CEOs. In most regressions, the t-statistics and the coefficients on financing incentives are somewhat higher when “holders” are excluded, in spite of the smaller sample size. This is consistent with the idea that my estimates of volatility costs are noisy or too high for the “holder” CEOs.

As a next step, I test more formally whether the coefficient on incentives is lower in the “holders” subsample. In particular, I re-run the probit, leverage level, and leverage change regressions using the full sample, and including an interaction term of volatility costs with the “holder” dummy. Again, I find some support for the overconfidence or risk-tolerance hypotheses: the coefficient on the interaction term is negative and significant in both the change and the level regressions for all three “holder” measures. Also, in both the change and the level regressions, the coefficient on incentives increases slightly and becomes more significant when the interaction term is included. However, I find no significant coefficient on the interaction term in the probit model, and including the interaction term has no significant impact on the probit results.

In sum, I find some evidence that financing decisions are less strongly associated with financing incentives for “holders” than for other CEOs, which is consistent with overconfidence or higher risk tolerance. Overall, the additional robustness tests support the main conclusion in the paper that volatility costs are associated with financing decisions, although the magnitude of these costs depends on managers’ preferences and attitudes towards risk.

4.5. Endogeneity of financing incentives, ownership, and leverage

One concern with the leverage level regressions discussed in Section 4.3 is that capital structure and executive compensation—a determinant of financing incentives—are likely simultaneously determined. This raises the concern that the coefficient on financing incentive 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, I have shown that the findings are robust using three different specifications: level regressions, change regressions, and a probit model of debt-equity choice. The latter two models might be less susceptible to endogeneity problems than the level regressions (see, e.g., Berger et al., 1997).

Consider the level regressions in Section 4.3. There are several reasons to treat executive equity ownership and leverage levels as endogenous. For example, both debt and equity
ownership could be employed as alternative means to limit free cash flow 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 cash flow problem. Other theories suggest that leverage and ownership are endogenous because of voting rights and control issues (Stulz, 1988; Harris and Raviv, 1988).

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

\[
\text{LEV} = \alpha_0 + \alpha_1 \text{IC} + \alpha_2 \text{OWN} + \alpha_3 Y_L + \epsilon_L, \tag{4}
\]

\[
\text{IC} = \beta_0 + \beta_1 \text{OWN} + \beta_2 Y_I + \epsilon_I, \tag{5}
\]

\[
\text{OWN} = \gamma_0 + \gamma_1 \text{LEV} + \gamma_2 Y_O + \epsilon_O. \tag{6}
\]

LEV denotes leverage, FI is the volatility cost of debt, OWN is executive ownership, and \(Y_L, Y_I, Y_O\) denote other determinants of leverage, volatility costs, and ownership, respectively. Eqs. (4) and (6) reflect the simultaneous determination of executive ownership and leverage, as suggested by Jensen (1986), Stulz (1988), and others. Eq. (5) shows that ownership is one of the factors that determine financing incentives. Therefore, FI is also endogenous: it is easy to see that FI will be correlated with the residual in Eq. (4).

In this model, a key assumption is that the endogeneity of FI is caused entirely by its correlation with OWN. As a consequence, if Eq. (4) is estimated by OLS, the coefficient on OWN absorbs the endogeneity bias and the coefficient on FI is unbiased. One can see this by decomposing the residual in Eq. (4) into a component that is correlated with ownership, \(\delta\text{OWN}\), and an orthogonal component, \(\epsilon'\). Substituting \(\epsilon_L = \delta\text{OWN} + \epsilon'\) into Eq. (4) yields

\[
\text{LEV} = \alpha_0 + \alpha_1 \text{IC} + (\alpha_2 + \delta)\text{OWN} + \alpha_3 Y_L + \epsilon'. \tag{7}
\]

Since \(\epsilon'\) is, by construction, uncorrelated with OWN and FI, Eq. (7) satisfies the standard OLS assumptions. This implies that the estimate of \(\alpha_1\) from Eq. (7) (or equivalently from Eq. (4)) will be unbiased.

I construct several measures of OWN to capture performance incentives and managerial voting control. In particular, I use stock and option ownership as a percent of shares outstanding, various 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, change, and probit regressions are robust to the inclusion of any of these measures. For simplicity, and to be consistent with prior studies, I report only regressions with stock and option ownership as a percent of shares outstanding. These robustness tests suggest that the relation between ownership and leverage does not drive the coefficient on incentives in the leverage regressions.

5. Summary and conclusions

This 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 stock price increases. The volatility effect, which reflects the divergence between shareholders’ and managerial 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 stock vs. options in the CEO portfolio, and the option exercise price).

Empirically, I find that managerial incentives seem to affect actual financing choices. Even with a wide variety of methodologies and control variables, the tests 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 the 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 between incentives and 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 managerial 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 significant impact on managers’ financing incentives and, perhaps more importantly, on observed financing decisions.

Appendix A. 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 (2004).

Define the manager’s derived utility from stock price as

\[ V(P) = U[f(P)], \quad (A.1) \]

where \( f(P) \) is the manager’s compensation as a function of stock price (\( f(P) \) 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 et al., 2006). The standard definition of relative risk aversion is

\[ R_U(W) = -\frac{U''(W)}{U'(W)} \cdot W, \quad (A.2) \]
where $W$ is wealth and $U(W)$ is the manager’s utility from wealth. However, since we are interested in evaluating the manager’s aversion to stock price risk, I focus on a slightly modified measure of risk aversion, based on the derived utility from price, $V(P)$:

$$RV(P) = -\frac{V''(P)}{V'(P)} \cdot P.$$  (A.3)

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 manager more or less averse to stock price risk in a close neighborhood of $P$. A simple way to answer 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 $U(P)$):

$$RV(P) - RU(P) = -\frac{U''(f) \cdot f'}{U'(f)} \cdot P - \left[ -\frac{U''(P)}{U'(P)} \cdot P \right] + \left[ -\frac{f''}{f} \cdot P \right]$$

$$= RU(f) \cdot \frac{P}{f} - RU(P) + R_f(P)$$

$$= \left[ RU(f) - RU(P) \right] + RU(f) \cdot \left[ \frac{P}{f} \cdot f' - 1 \right] + R_f(P).$$  (A.4)

Eq. (A.4) shows that the total effect of $f(P)$ on the manager’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 Fig. 2 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**  
$= RU(f) \cdot \left[ \frac{P}{f} \cdot f' - 1 \right] = R_f(P)$

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 the stock price on a percentage change in $f(P)$. Consequently, the magnification effect makes the manager more averse to stock price volatility. Consider again the payoff in Fig. 2 that involves $N$ shares of stock and $M$ call options with exercise price $K$. Note that for $P > K$, the payoff elasticity equals $\left[ P \cdot (M+N)/(P \cdot (M+N) - M \cdot K) \right]$, 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.

\[ Translation\ effect\ =\ R_L(f) - R_L(P) \]

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

The analysis here uses a general concave utility function and 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 $R_L(f)$, 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 eliminated for CRRA utility. Most experiments in Section 2 hold wealth constant: for example, Fig. 1 examines portfolios with different proportions of shares and options but with the same Black-Scholes value. Since in this case, the translation effect is small, I expect that the results in Fig. 1 are not sensitive to the choice of utility function. To check this, I replicate Fig. 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. I find that replacing CRRA with CARA utility has little effect on the shape of the curves representing financing incentives in Fig. 1.

Appendix B. 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.

B.1. Estimation

In contrast to Section 2, I assume that asset returns $(1 + \tilde{R}_A)$, 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 $\tilde{r}_A$, which is normally distributed:

\[ \tilde{r}_A = \log(1 + \tilde{R}_A) \sim N(\mu_A, \sigma_A). \]  

Shareholders hold a call option on corporate assets with an 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 off 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

\[
E = A \cdot N(X) - F \cdot e^{-TD\hat{r}} \cdot N(X - \sigma_A \sqrt{T_D}),
\]

where \( T_D \) is the time to maturity of debt, \( \hat{r} \) is the instantaneous risk-free rate, and \( N(\cdot) \) 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, with stock prices determined by Black-Scholes; (3) I repeat the second step for the new hypothetical leverage level; and (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, \( \tilde{r}_A \):

\[
\mu - \tilde{r}_f = \Omega \cdot [\mu_A - \tilde{r}_f], \tag{B.4}
\]

\[
\sigma = \Omega \cdot \sigma_A, \tag{B.5}
\]

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

\[
\Omega = \frac{A}{E} \cdot N(X) = \frac{1}{1 - L} \cdot N(X). \tag{B.6}
\]

Note that \( N(X) \) is the option’s delta defined in Eq. (B.3). To obtain the unknown parameters \( \sigma_A, \mu_A, \) and \( A \), I solve numerically Eqs. (B.2)–(B.5), using the actual current equity value as \( E \), and the book value of debt as a proxy for \( F \cdot e^{-TD\hat{r}} \). For simplicity, I set \( T_D \) to 10 years for all firms, approximating the maturity of long-term debt.

Eqs. (B.4) and (B.5) “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 the option’s delta, \( N(X) \), is close to one, the “unlevering” formulas (B.4) and (B.5) 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 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 $A$:

$$\tilde{A}_T = A \cdot e^{T\tilde{r}_A} \text{ with } \tilde{r}_A \sim N(\mu_A, \sigma_A). \quad (B.7)$$

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

(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 the dollar proceeds from the issue. If the recapitalization has no effect on the firm’s assets, the distribution of asset values at time $T$ is identical to that described in step (2), i.e., $\tilde{A}_T^1 = \tilde{A}_T$. Similarly, the distribution of equity values at time $T$ at the new leverage, $\tilde{E}_T^1$, 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 $\tilde{P}_T^1 = \tilde{E}_T^1 / N^1$.

(4) Computation of financing incentives

After simulating stock prices, I compute certainty equivalents and incentives 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, $FI$ 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, $FI^B$, measures the impact of a leverage change on the CEO through two separate effects: the volatility effect and 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 $FI^{BV}$) is obtained similarly to $FI^B$, except that, before computing the certainty
equivalent at $L^1$, I multiply $\tilde{P}^1_T$ by a factor $P^0/P^1$. This factor adjusts the incentive estimate for the stock price appreciation at the announcement caused by the wealth transfer. All the remaining steps in the calculation follow the algorithm described in this appendix.

### B.2. Results

The new estimates of incentives ($\text{FI}^{BV}$) are less negative but similar in magnitude to the old estimates in Table 4 (FI). For example, the mean (median) $\text{FI}^{BV}$ is $-3.16\% (-2.8\%)$ and the mean (median) FI 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 subsample of firms with below-median market leverage (the median is 15%). As expected, the difference between $\text{FI}^{BV}$ and FI is much smaller for these firms, with the mean (median) $\text{FI}^{BV}$ of $-3.43\% (-3.16\%)$ and the mean (median) FI of $-3.97\% (-3.48\%)$. Similarly, the correlation between $\text{FI}^{BV}$ and FI is 87% for the subsample with below-median leverage, and it is 47% for the whole sample. As a robustness test, I re-run the tests in the paper using the new set of estimates. The results in the probit model are somewhat stronger than those in Table 5, and they are similar when the pure volatility effect (FI$^{BV}$) or the combined volatility and wealth effect (FI$^B$) are used to measure incentives. As described in Section 4.2, the results in the change regressions are weaker when the new incentives estimate is used. Although the coefficients on $\Delta\text{FI}^{BV}$ (and $\Delta\text{FI}^B$) are still positive, they are smaller than in Table 6 and are not statistically significant. Finally, to check 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 is 94%), independent of the estimate I use.

### References


