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Agency and Corporate Investment: The Role of Executive Compensation and Corporate Governance*

The agency theory of the firm implies that executive incentive compensation and corporate investment policies are endogenously determined. We estimate jointly the relationship between long-term corporate investment and CEO incentive compensation structure, while considering the strength of corporate governance mechanisms. The analysis indicates that long-term business investment is positively related to the weight placed on equity-based incentive compensation, after controlling for internal financing constraints and the quality of the investment opportunity set. We also confirm that CEO compensation structure is influenced by factors that represent the strength of the firm's internal governance mechanisms.

I. Introduction

How do shareholder-manager conflicts affect corporate investment? According to the agency theory of the firm, shareholders design executive compensation contracts ex ante to minimize agency costs, after taking into account the impact of incentive compensation on managers' self-interested behavior (Jensen and Meckling 1976; Smith and Watts 1992). The standard optimal contracting framework (e.g., Ross 1973; Holmstrom 1979) then suggests that managers' investment and financing decisions are endogenously

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and jointly determined in a second-best (or information-constrained efficient) incentive arrangement.

We also know that equity-based compensation—including restricted stock awards and stock options—is an increasingly important component of executive compensation (Yermack 1995; Hall and Liebman 1998; Mehran and Tracy 2001).[1] Recent studies show that equity-based executive compensation influences corporate *financial* policies, including dividend payouts and capital structure decisions (Lambert, Lannen, and Larcker 1989; Mehran 1992; White 1996; Berger, Ofek, and Yermack 1997; Fenn and Liang 2001). Empirical support for a relation between equity compensation and corporate investment policy is not well documented, however. This is surprising, because a large body of theoretical literature considers agency conflicts and managerial compensation in an investment decision context (e.g., Ross 1973; Holmstrom and Weiss 1985; Campbell, Chan, and Marino 1989; Hirshleifer and Suh 1992).[2]

We contribute to the literature by considering the role of executive compensation structure on investment spending. Using compensation and investment data for 1992–2000, we establish that equity-based executive compensation is an important determinant of long-term capital investments of U.S. corporations, consistent with theoretical predictions that agency conflicts influence long-term corporate investment. Our analysis also suggests that empirical specifications of business investment that ignore the joint determination of investment and managerial incentive compensation are incomplete.[3]

A substantial literature in economics and finance considers the determinants of corporate investment.[4] While early literature addresses investment policy in the context of maximizing discounted expected profits in frictionless capital markets, more recent literature investigates the role of capital market frictions and internal liquidity constraints on investment decisions (Whited 1992; Fazzari and Petersen 1993; Hubbard, Kashyap, and Whited 1995; Lamont 1997). We build on this research by developing an enhanced investment specification that incorporates equity-based compensation as a vehicle to alleviate agency conflicts with respect to investment. The empirical analysis is of special interest because the theoretical agency literature implies that executive incentive compensation and corporate investments are related, but it is ambiguous regarding the sign of the association.

The recent agency literature also emphasizes the role of corporate governance in business decisions (e.g., Fama and Jensen 1983; Hermalin and Weisbach 1991; Jensen 1993; Shleifer and Vishny 1997). Furthermore, investment, financing, and corporate governance are interrelated and are jointly determined

1. Of course, equity-based compensation only approximates the total incentive provision provided by managerial compensation contracts, which usually have many complex features (e.g., Kole 1997).

2. Murphy (1999) provides a useful survey of the theoretical and empirical literature studying the association between executive compensation and corporate financial and investment policies.

3. Mehran (1992) reaches a similar conclusion with respect to corporate capital structure decisions.

4. See Abel (1980) and Chirinko (1993) for a survey of this literature.

in equilibrium (Demsetz and Lehn 1985; Smith and Watts 1992; Mehran 1995). Accordingly, we examine the relation between executive equity compensation and corporate investment, taking into account equity ownership of chief executive officers and other firm characteristics that reflect the strength of corporate governance. More specifically, we simultaneously estimate an augmented, reduced-form investment equation (e.g., Fazzari and Petersen 1993) and a compensation equation (e.g., Mehran 1995). Thus the research design recognizes that investment and executive incentive compensation are jointly determined in equilibrium. We then test the hypotheses that the level of long-term investment is influenced by the relative weight on CEO equity-based compensation and that the weight of equity-based compensation is, in turn, affected by the desired level of investment.

We find that long-term investment spending increases with the weight placed on CEO equity-based compensation after controlling for Tobin's *Q* and financing constraints. This result shows that, in addition to expected profitability and financing constraints previously emphasized (Whited 1992; Fazzari and Petersen 1993; Hubbard et al. 1995), equity-based top-management incentive compensation is a significant determinant of corporate investment. Thus existing empirical specifications in the corporate investment literature apparently omit an important determinant. This result is consistent with previous research that examines more specific investment decisions, such as takeovers (Agrawal and Mandelker 1987) or liquidations (Mehran, Nogler, and Schwartz 1998).[5]

We also show that the emphasis placed on executive equity-based compensation is positively related to variables that proxy for the severity of agency conflicts within the firm, consistent with past research. Specifically, the weight placed on equity-based compensation is greater when (i) the investment opportunity set is greater (Smith and Watts 1992); (ii) the CEO owns a smaller stake in the firm (Mehran 1995); (iii) the CEO's tenure is shorter (Eaton and Rosen 1983); (iv) the firm faces a liquidity constraint (Fazzari, Hubbard, and Petersen 1988; Yermack 1995); and (v) the firm is larger (Smith and Watts 1992).

We organize the remainder of the paper as follows. Section II provides an overview of the literature and develops an empirical specification of investment that considers the influence of equity compensation. Section III explains the research methodology. Section IV explains the data collection process and describes the sample. Section V reports the empirical results, and Section VI presents the conclusion.

5. Agrawal and Mandelker (1987) examine the impact of managerial stock and option holdings on their incentives to increase the firm's risk in takeover decisions. Mehran et al. (1998) more directly examine the effect of equity compensation on managerial decisions by demonstrating that CEO's stock ownership and equity options influence firms' liquidation decisions and increase shareholder value.

II. Background and Motivation

A. Investment Policy with Agency Conflicts

A rich body of theoretical research relates agency conflicts with corporate investment, although the predictions from this literature are not necessarily unanimous as to whether under- or overinvestment occurs as agency conflicts become more substantial. Wilson (1969), Ross (1973), and Amihud and Lev (1981) consider investment conflicts between owners and managers due to incongruities in risk preferences. Divergent attitudes about risk can encourage both under- and overinvestment, but the usual presumption is that managers underinvest because they cannot fully diversify the risk of firm-specific human capital (e.g., Amihud and Lev 1981).

Agency conflicts can also influence investment policy when investment performance depends on costly managerial effort. Moral hazard with respect to effort leads to moral hazard with respect to investment (Christensen 1981; Holmstrom and Weiss 1985; Lambert 1986; Hirshleifer and Suh 1992). Similar conflicts also arise when investment performance affects the manager's reputation in terms of ability or competence (Holmstrom and Ricart i Costa 1986; Campbell et al. 1989; Hirshleifer and Thakor 1992). Generally, these models indicate underinvestment in the optimal incentive-contracting equilibrium.

Another literature suggests investment distortions attributable to private information regarding investment prospects, although these analyses are typically not set in a principal-agent context. Myers and Majluf (1984) and Miller and Rock (1985) find that underinvestment is an equilibrium outcome of adverse selection regarding investment prospects. Other arguments indicate underinvestment when managers face a limited payout horizon (Froot, Perold, and Stein 1992; Smith and Watts 1992). Further, studies suggest that U.S. managers overemphasize short-term profits at the expense of long-term value creation (Dertouzos, Lester, and Solow 1988; Porter 1992; Jacobson and Aaker 1993).

By contrast, a growing literature, building on Jensen (1986, 1993), argues that CEOs receive private benefits from investment, and the existing corporate governance practices permit powerful CEOs to overinvest (or engage in "empire building") by accepting negative net present value projects. For example, Stulz (1990), Hart (1995), Zwiebel (1996), and Fluck (1999) theoretically examine the interaction between firm investment and financial policy when entrenched managers attempt to maximize assets under their control.

In light of these incentive problems, at issue is the extent to which managerial compensation contracts can be designed to encourage investment that is more consistent with shareholder preferences. Irrespective of the *source* of the shareholder-manager conflict, the literature shows that *endogenously* designed, performance-based incentive contracts mitigate the impact of agency conflicts on investment. Dechow and Sloan (1991) and Lambert and Larcker (1991) also recommend performance-based incentives for ameliorating adverse effects of the shareholder-manager conflict over investment horizons.

In practice, equity-based compensation is the most prominent form of performance-based compensation that is considered in the literature.[6] For example, Murphy (1985) and Jensen and Murphy (1990) note that CEO pay, when heavily weighted toward equity-based compensation, extends the manager's decision horizon and, thus, promotes value-increasing investments.[7] Garvey (1997) also shows that tying CEO compensation to shareholder wealth helps mitigate the empire-building moral hazard.

There is a large and growing literature that examines the relationship between executive equity compensation and capital structure and payout decisions (e.g., Lambert et al. 1989; Mehran 1992; White 1996; Berger et al. 1997; Fenn and Liang 2001). However, the literature rarely examines systematically the empirical importance of executive equity-based compensation for long-term capital investment policy, except for the few studies that examine important, but somewhat specific, investment decisions such as takeovers or liquidations (Agrawal and Mandelker 1987; Mehran et al. 1998). This paper examines the relationship between long-term investment expenditure—which is the focus of numerous studies in corporate investment—and executive compensation structure, taking into account the joint determination of investment and executive equity compensation.

B. Investment Spending and Top-Management Incentive Compensation

The existing literature implies that firms adopt specific equity compensation structures to elicit desired investment levels. The theory is silent, however, on what directional relationship will emerge from data. Therefore, our first null hypothesis asserts that the level of long-term investment is not related to equity-based CEO compensation.

HYPOTHESIS 1. Long-term investment spending is unaffected by the weight placed on equity-based compensation.

A rejection of the null hypothesis in favor of a negative (positive) relation implies that long-term investment decreases (increases) with greater weight placed on equity-based compensation. It is important to note, first, that we are not testing for the optimality of investment levels—notwithstanding that it is an important, unanswered question. Instead, we are testing for an alternative conjecture that the weight placed on equity-based compensation affects long-term investment. Second, we are primarily interested in a cross-sectional relationship, and thus outcomes of our test cannot be interpreted as evidence of a within-firm *causal* relationship between incentive compensation and busi-

6. Ross (1973) shows that information-constrained efficient investment can be implemented through a contract that is increasing in firm performance and that an optimal compensation schedule can be "mimicked" through equity awards.

7. However, Bizjak, Brickley, and Coles (1993) point out that if equity compensation is tied to short- rather than long-term stock returns, then it may actually provide incentives for informed insiders to distort investment policy in order to manipulate the stock market. Thus equity-based compensation by itself is not the answer to managerial myopia; managerial wealth needs to be tied to long-term stock returns.

ness investment. As such, the paper does not resolve the issue of whether underinvestment or empire building is the binding agency constraint in the design of executive compensation (see, e.g., Aggarwal and Samwick 2002).

C. Compensation Structure and Managerial Incentives

From the perspective that executive incentive compensation structure and desired level of investment are jointly determined (Demsetz and Lehn 1985; Smith and Watts 1992; Mehran 1995), we posit the second hypothesis as follows.

HYPOTHESIS 2. The weight placed on top-management equity-based compensation is unaffected by the desired level of long-term investment.

Under the alternative hypothesis, a desired level of investment requires a specific compensation structure, which in turn induces the manager to take the targeted level of investment. Thus there should be an association between *actual* level of investment and the compensation structure.

The literature also finds that the quality of investment *prospects* (or growth opportunities) is a major factor shaping the structure of CEO compensation (Lewellen, Loderer, and Martin 1987; Smith and Watts 1992; Gaver and Gaver 1993; Mehran 1995). Smith and Watts (1992), noting a positive relation between information asymmetry and the presence of growth opportunities, predict that firms with growth opportunities will use more performance-based compensation such as cash bonuses or stock options. Extending this argument, Bizjak et al. (1993) and Yermack (1995) predict that growth firms place more emphasis on long-term performance, favoring equity-based compensation. Since the *actual* level of investment and the measures for *expected* growth opportunities (e.g., market-to-book or Tobin's *Q* estimates) are both proxies for desired level of investment, we use both measures to test hypothesis 2.

Various approaches to the design of executive performance-contingent compensation also suggest that the compensation structure (i.e., the weight placed on equity-based components of CEO compensation) is influenced by the effectiveness of CEO monitoring mechanisms. For example, Hirshleifer and Suh (1992) arrive at this conclusion by studying the design of optimal profit-based incentive compensation. The incomplete contracting literature also argues that, in the absence of complete contingent contracting, there is a role for governance mechanisms to monitor the CEO (see Shleifer and Vishny 1986; Aghion and Bolton 1992; Hart 1995). We thus consider the role of governance mechanisms as a determinant of the compensation structure as described in the following section.

III. Empirical Specifications and Estimation Issues

A. The Model

We begin with the contemporary investment literature that employs the augmented Q equation to incorporate financing constraints (Hoshi, Kashyap, and Scharfstein 1991; Fazzari and Petersen 1993):

$$\frac{I_t}{K_t} = \alpha_0 + \alpha_1 Q_t + f(\text{financial constraint variables}) + \text{error}_t, \qquad (1)$$

where K_t is the capital stock, I_t is the investment in period t, and Q_t is the ratio of the market value of the firm to the replacement cost of the firm's existing capital stock (Tobin 1969). Internally generated cash flows serve as a proxy for the financial constraint in the investment literature. Existing research predominantly finds that cash flows have significant additional explanatory power, consistent with binding internal financial constraints.

A principal contribution of this study is to point out that the Q equation is incomplete since it ignores moral hazard with respect to investment and the impact of incentive compensation. To introduce these effects parsimoniously, we augment the Q equation with a variable that measures incentive strength provided by equity compensation, designated as WEIGHT:

$$\frac{I_t}{K_t} = \alpha_0 + \alpha_1 \text{WEIGHT}_t + \alpha_2 Q_t + f(\text{financial constraint variables}) + \text{error}_t. \qquad (2)$$

Hypothesis 1 imposes the restriction that the coefficient for WEIGHT is zero.

On the basis of the preceding discussions of hypotheses 1 and 2, we estimate the investment equation simultaneously with the following compensation equation:

$$\text{WEIGHT}_t = \beta_0 + \beta_1 \frac{I_t}{K_t} + g(\text{control variables}) + \text{error}_t. \qquad (3)$$

Hypothesis 2 implies that the coefficient β_1 for actual investment (I/K), or a proxy for investment prospects (Q), is zero.

The agency literature asserts that, in addition to the desired level of investment, agency considerations affect the design of the compensation structure. Thus control variables refer to various agency-related variables that potentially affect the structure of compensation. A detailed discussion of these variables follows.

B. Specification

A complete specification of the control variables yields a system of two equations (the firm and the time subscripts are omitted; expected signs are in parentheses):

Investment equation:

$$I/K = \underset{(+/-)}{\alpha_0 + \alpha_1 \cdot \text{WEIGHT}} + \underset{(+)}{\alpha_2 \cdot Q} + \underset{(+)}{\alpha_3 \cdot \text{CASHFLOW}} + \underset{(+)}{\alpha_4 \cdot \text{SALES}} + \text{fiscal year and industry controls} + \varepsilon; \quad (4)$$

Compensation equation:

$$\text{WEIGHT} = \underset{(+)}{\beta_0 + \beta_1 \cdot I/K} + \underset{(-)}{\beta_2 \cdot \text{CEO\_HOLD}} + \underset{(-)}{\beta_3 \cdot \text{TENURE}} + \underset{(+)}{\beta_4 \cdot \text{LIQUID}} + \underset{(+)}{\beta_5 \cdot \text{SIZE}} + \underset{(-)}{\beta_6 \cdot \text{LEVERAGE}} + \text{fiscal year and industry controls} + \eta. \quad (5)$$

Precise definitions of all variables are in table 1 below. The term I/K is the sum of capital expenditures, R&D expenditures, and acquisitions, deflated by beginning-of-the-year property, plant, and equipment (PP&E) and capitalized R&D. The inclusion of R&D and acquisitions in the numerator (I) goes beyond the existing literature that considers only capital expenditures.[8] Further, the extant literature typically uses beginning-of-the-year PP&E or replacement cost of assets for the denominator (K) (e.g., Hoshi et al. 1991; Fazzari and Petersen 1993). Since we treat current-period R&D expenditures as a productive investment and include it in the numerator, we also add capitalized (and depreciated) R&D *stock* to the denominator.[9]

We consider two measures of WEIGHT. The first is the ratio of the CEO's equity-based compensation—stock options, stock appreciation rights (SARs), and restricted stocks—awarded in year t to the total CEO compensation awarded for the year. This definition is in keeping with the literature (e.g., Eaton and Rosen 1983; Mehran 1995; Sanders, Davis-Blake, and Frederickson 1995; Bryan et al. 2000). Notice that a higher value of WEIGHT implies that a greater proportion of CEO compensation depends on current and future stock performance, since the value of stocks or options by construction must

8. Bryan, Hwang, and Lilien (2000) show that executive incentive compensation is related to the quality of the investment opportunity set (for which R&D investment is a proxy), but they do not examine the impact of incentive compensation on investment spending.

9. We assume five-year straight-line depreciation for R&D, but our conclusions are unaffected when we use 10-year depreciation (a 15-year depreciation is infeasible because of a significant loss of sample data). Capitalized R&D of year t is calculated as

$$0.9 \times \text{R\&D}_t + 0.7 \times \text{R\&D}_{t-1} + 0.5 \times \text{R\&D}_{t-2} + 0.3 \times \text{R\&D}_{t-3} + 0.1 \times \text{R\&D}_{t-4},$$

where $\text{R\&D}_t$ is R&D spending in year t. This procedure assumes that R&D spending is made uniformly across the year. The value of the R&D recorded as "unavailable" in the Compustat files is assumed to be zero as long as sales data are available.

be correlated with current and future stock performance. Thus WEIGHT is a simple but powerful indicator of the CEO's equity incentives.

The second measure of WEIGHT is the CEO's pay-performance sensitivity, or PPS (Jensen and Murphy 1990), that is, the sensitivity of the CEO's total compensation to changes in shareholder wealth. We measure PPS as the slope coefficient obtained from regressing the change in total CEO compensation (deflated by beginning-of-the-year market value of equity) on stock returns. The application of this measure is limited in our sample (see Sec. IV) for several reasons. First, estimating pay-performance sensitivity requires reasonably long time series to obtain precise estimates, but available databases such as ExecuComp provide only a few annual observations. Second, since PPS measures the covariance between stock performance and *both* equity and nonequity awards, it does not directly measure the importance of equity compensation. Nevertheless, the covariance between equity awards and stock returns likely dominates the PPS estimates.

We use market-to-book ratio computed *at the beginning of the year* (Smith and Watts 1992; Gaver and Gaver 1993; Yermack 1995) as a measure for *Q*. We also employ a conventional Tobin's *Q* estimate computed according to the algorithm developed by Perfect and Wiles (1994). Results are invariant to alternative measures of *Q*, and thus we report results based on the market-to-book ratio to address a larger sample.

We expect both CASHFLOW and SALES to play a role in the presence of financial constraints. Most studies measure CASHFLOW as net income before extraordinary items plus depreciation, but this quantity represents available cash flows *after* R&D investments are made. Consistent with the notion that R&D is a productive investment, we define CASHFLOW as cash flows available *before* making capital *and* R&D investments; that is, we add the after-tax cost of R&D expenditures to net income. Finally, most studies use SALES as a control variable for certain omitted aspects of the "true" *Q* or cash flows (e.g., Fazzari and Petersen 1993).

For the compensation equation, we consider stockholdings of the CEO (CEO_HOLD), the CEO's tenure (TENURE), firm size (SIZE), firm's liquidity (LIQUID), and financial leverage (LEVERAGE). These variables are motivated from the agency literature and address the CEO's power and the effectiveness of internal governance mechanisms. On the basis of most accepted theories of executive compensation, we expect these variables to affect executive compensation structure in the following manner.

First, we expect that a lower current share ownership of the CEO leads to relatively more emphasis on equity-based compensation to align the CEO's interest with that of the shareholders (Jensen and Meckling 1976; Mehran 1995). Thus we expect a negative coefficient for CEO_HOLD.

The CEO's tenure (TENURE) represents the career status of the CEO. According to Eaton and Rosen (1983), younger managers are compensated with riskier forms of long-term compensation (such as stock options) since

they are less risk-averse, and thus we expect a negative coefficient. However, the literature also advances an alternative prediction that the explicit incentive compensation of managers should increase as they approach retirement, since the implicit incentives of careers and promotion are weakened at this stage (see, e.g., Gibbons and Murphy 1992a, 1992b; Murphy and Zimmerman 1993). According to this perspective, equity-based compensation should increase near retirement and we should expect a positive coefficient.[10]

The remaining variables (LIQUID, LEVERAGE, and SIZE) address liquidity constraints on noncash compensation awards and the need for monitoring. Since equity-based compensation does not require immediate cash outlays, firms facing a liquidity constraint tend to rely more on this form of compensation. Following Fazzari et al. (1988) and Yermack (1995), we include liquidity constraints (LIQUID) as an indicator variable that equals one if the firm does not pay dividends and is zero otherwise. Thus we expect a positive coefficient for LIQUID.

Building on the analysis of John and John (1993), Yermack (1995) hypothesizes that incentives provided by stock options decrease as financial leverage (LEVERAGE) increases, because the firm attempts to reduce expected agency costs of debt. Mehran (1995) finds a negative but statistically insignificant association between leverage and the proportion of a CEO's total compensation given by incentive plans. The expected sign for LEVERAGE is therefore negative.

Finally, Eaton and Rosen (1983) argue that monitoring becomes more difficult as firm size (SIZE) increases. If so and if equity-based compensation and monitoring are substitutes as hypothesized by Smith and Watts (1992), we expect larger firms to offer relatively greater equity-based compensation and, thus, a positive sign for SIZE.

C. Estimation Issues

Several issues arise regarding the estimation of the system of equations (4) and (5). First, the compensation structure (WEIGHT) is zero when a firm awards no equity-based bonuses (primarily stock options). Since this is the case for a large number of observations (25.9% of our sample firm-years), direct application of the two-stage least-squares methodology can yield biased estimates. We thus estimate the compensation equation using Tobit.[11] Since it is often infeasible to maximize the likelihood function of a simultaneous equation model with censored variables, we estimate equations (4) and (5)

10. Gibbons and Murphy (1992b) provide some supporting evidence for this conjecture based on the sensitivity of cash salary to current performance. However, they do not examine equity compensation. We also note that according to Brickley, Linck, and Coles (1999), the CEO's performance during his or her tenure is positively related to the likelihood of postretirement directorship.

11. By using Tobit, we are, in effect, assuming that the equity awards are censored. An alternative approach based on Heckman (1979) yields similar conclusions.

using the two-stage method proposed by Nelson and Olsen (1978), which yields consistent estimates.

Second, we employ panel data containing a large number of cross sections but a small number of time-series observations (see Sec. IV below). The paucity of time-series observations makes it difficult to establish a causal relationship between WEIGHT and *I*/*K* at the firm level, especially because the existing literature offers little guidance regarding the appropriate lag structure for the investment or the compensation equation.[12] Thus we focus on the cross-sectional relationship and estimate (4) and (5) not only as a pooled time-series cross-sectional regression, but also as a regression using firm-specific means.

IV. Data and Sample Description

We use the S&P ExecuComp database, which contains 1992–2000 compensation data for U.S. executives. Financial and stock price data are taken from Compustat primary, secondary, tertiary, and full-coverage files and the files of the Center for Research in Security Prices. CEO stockholdings and tenure, as well as the stock option values (based on the straightforward application of the Black-Scholes [1973] model), are taken from the data reported in ExecuComp.

We exclude firms (i) in which the CEO did not serve a full year, since prorated compensation is unlikely to be comparable to full-year compensation; (ii) in the banking industry (Standard Industrial Classification [SIC] 60) because capital expenditure information is unavailable; and (iii) that lack financial data to calculate the explanatory variables. Finally, to mitigate the influence of extreme observations, we remove observations that rank beyond the extreme 0.5 percentile of *I*/*K*, *Q*, CASHFLOW, SALES, and LEVERAGE. Our final sample is composed of 9,379 CEO-year observations for 2,261 CEOs.

The ExecuComp sample is skewed toward large firms. For example, more than 47% of the sample firms are within the top twentieth percentile of all Compustat firms in terms of total assets, and more than 93% are in the top fiftieth percentile in total assets. On the basis of the four-digit SIC classification, 314 industries are represented in the sample, and firm size ranges from $4.5 million to $380 billion in total assets.

Table 1 displays summary statistics. The sample mean of the total CEO compensation is $2.984 million. The average decomposition of this compensation (untabulated) is as follows: 38% is base salary, 19% is cash bonus, 31% is options or SARs, 4% is restricted stock, 3% is long-term incentive payouts (LTIP), and 4% is "other" miscellaneous compensation. Thus, on

12. For example, equity compensation awarded in a specific year can affect capital expenditures in the same year for some firms, but after several years for other firms.

TABLE 1 Summary Statistics

	Mean	Median	Standard Deviation	Minimum	Maximum
Total assets ($millions)	4,691	884	17,750	4.5	380,005
Total compensation ($millions)	2.984	1.388	10.411	.001	600.302
Equity-based compensation ($millions)	1.723	.432	9.519	.000	579.014
WEIGHT	.348	.331	.289	.000	1.000
I/*K*	.538	.327	.795	.000	10.324
Q	2.359	1.692	1.885	.413	16.372
CASHFLOW	.543	.338	.857	−2.186	10.821
SALES	6.409	3.211	11.185	.006	126.190
CEO_HOLD	.031	.003	.071	.000	.994
TENURE	7.9	5.6	7.507	1.0	55.0
LIQUID	.395	.000	.489	.000	1.000
SIZE	20.741	20.600	1.633	15.323	26.663
LEVERAGE	.341	.353	.231	.000	.994

NOTE.—All dollar values are expressed in 1993 dollars. Total compensation includes salary, bonuses, SARs, restricted stocks, LTIPs, and other compensation. Equity-based compensation includes stock options, SARs, and restricted stocks. WEIGHT is the ratio of equity-based compensation to total compensation; *I*/*K* is (capital expenditures + R&D expenditures + acquisitions)/(beginning-of-the-year PP&E + capitalized R&D), where capitalized R&D of year *t* is calculated as

$$0.9 \times \text{R\&D}_t + 0.7 \times \text{R\&D}_{t-1} + 0.5 \times \text{R\&D}_{t-2} + 0.3 \times \text{R\&D}_{t-3} + 0.1 \times \text{R\&D}_{t-4},$$

where $\text{R\&D}_t$ is R&D spending in year *t*; *Q* is the beginning-of-the-year (market value)/(book value of total capitalization), where the numerator is the market value of the firm's equity plus book value of interest-bearing debt; CASHFLOW is (net income + depreciation + amortization + deferred tax + after-tax R&D expenditures)/(beginning-of-the-year net PP&E + capitalized R&D); SALES is (net sales revenue)/(beginning-of-the-year net PP&E + capitalized R&D); CEO_HOLD is the fraction of the firm's equity held by the CEO; TENURE is the number of years since being appointed CEO; LIQUID is an indicator variable that equals unity if the firm paid no dividends in the year, zero otherwise; SIZE is the natural log of total assets of the year in 1993 dollars; and LEVERAGE is (interest-bearing debt)/(book value of equity + interest-bearing debt).

average, the long-term equity-based compensation (stock options, SARs, and restricted stocks) is about 35% of the total compensation (WEIGHT).

The mean (median) long-term investment spending is about 53.8% (32.7%) of the capital stock (*I*/*K*). The median *Q* ratio (1.692) significantly exceeds unity by a substantial margin, possibly reflecting the sample period in which the stock market was in the upturn. On average, CEOs own about 3% of the outstanding equity (CEO_HOLD) and have served as CEO for about eight years. The median sample firm's leverage (LEVERAGE) is 34.1% of total capitalization, and 39.5% of the sample firms do not pay dividends (LIQUID).

V. Results

A. Primary Results

Table 2 reports estimated coefficients and test statistics for the sample. All specifications include industry dummy variables (IND_DUM) categorized into 36 major industry groups and fiscal year dummy variables (coefficients not tabulated).

The most striking observation is that long-term investment spending (*I*/*K*)

TABLE 2 Estimates for Investment and Compensation Equations

	Investment Equation: OLS Estimates			Compensation Equation: Tobit Estimates	
	Predicted Sign	Dependent Variable: *I/K* (1)		Predicted Sign	Dependent Variable: WEIGHT (2)
Intercept		.210	Intercept		−2.024
		(2.83)**			[392.49]**
WEIGHT	+/−	.835	*I/K*	+	.100
		(6.10)**			[22.82]**
Q	+	.038	CEO_HOLD	−	.214
		(8.55)**			[2.92]*
CASHFLOW	+	.169	TENURE	−	−.005
		(14.74)**			[42.18]**
SALES	+	.018	LIQUID	+	.256
		(20.75)**			[311.24]**
			SIZE	+	.056
					[155.64]**
			LEVERAGE	−	−.072
					[5.80]**
Observations		9,379	Observations		9,379
Adjusted R^2		.226	Log likelihood		−6,122.5

NOTE.—The estimated equations are eqq. (4) and (5) in the text. All estimates are based on the two-stage Tobit estimation method of Nelson and Olsen (1978). Coefficients for fiscal year (YEAR_DUM) and industry indicator (IND_DUM) variables, included in all specifications, are not reported. All other variables are defined in the note to table 1. *t*-statistics in are parentheses χ^2 statistics in brackets.

* Significant at the .10 level, two-sided test.

** Significant at the .05 level, two-sided test.

is significantly and positively associated with the compensation structure (WEIGHT), in both the compensation and the investment equations. For the investment equation (col. 1), the compensation coefficient of 0.835 indicates that, with all else held constant, a firm awarding 10% more equity-based compensation (relative to total compensation) also outspends the average firm in capital expenditures by about 8.4% of the beginning-of-the-year capital stock. Thus the relation is economically significant. For example, the mean capital stock of $1,627 million in the sample implies that long-term investment spending is higher by approximately $137 million ($= \$1{,}627 \times 8.4\%$) for each 10% increase in WEIGHT. The evidence thus rejects hypothesis 1 in favor of a positive influence of equity-based compensation on long-term investment spending.

We also find that investment spending is positively and significantly related to *Q* (0.038; $t = 8.55$), consistent with the evidence presented elsewhere (e.g., Hoshi et al. 1991; Fazzari and Petersen 1993). The positive estimate for CASHFLOW, also in keeping with existing studies, suggests that availability of internal cash is a binding constraint on investment spending. The significant and positive influence of CEO equity-based compensation on investment spending implies that models of business investment spending ignoring the role of agency costs are incomplete.

Having observed that long-term business investment spending is signifi-

cantly associated with the structure of CEO equity compensation, we turn to the compensation equation (col. 2) to relate results to hypothesis 2. The positive I/K coefficient of 0.100 has the expected sign, indicating that higher desired investment levels lead to greater emphasis on executive equity-based compensation.

Since expected investment opportunity and actual investments are both proxies for unobservable desired investment, Q can be used in the compensation equation. Thus, as a robustness check, we reestimate the compensation equation by replacing realized investment I/K with Q.[13] Results are comparable except that the significance level for Q is higher. The positive association between Q and WEIGHT is qualitatively consistent with the evidence in Smith and Watts (1992), Bizjak et al. (1993), and Mehran (1995).[14]

With the exception of CEO stock ownership (CEO_HOLD), which has a wrong sign at the 10% significance level, the estimates for the remaining variables are consistent with the predictions. Specifically, the estimate for CEO tenure (TENURE) is negative at the 1% significance level, consistent with Eaton and Rosen's (1983) argument that inexperienced CEOs are less risk averse than seasoned CEOs who prefer less risky forms of compensation. The negative influence of CEO tenure on the proportion of equity-based to total CEO compensation is also consistent with recent research supporting the argument that tenure and CEO power are positively correlated, ceteris paribus (e.g., Cyert, Kang, and Kumar 2002), and that entrenched managers prefer non-performance-contingent compensation to incentive compensation (e.g., Murphy 1986; Finkelstein and Hambrick 1989).

Yermack (1995) reports that incentives provided by stock options are unrelated to most agency variables except for liquidity constraints and relative noise in accounting performance measures vis-à-vis stock returns.[15] The positive coefficient for liquidity (LIQUID) is consistent with the results in Yermack (1995), indicating that firms facing liquidity constraints (zero-dividend firms) encourage the use of equity-based compensation to conserve internal funds.

Finally, larger firms put more emphasis on equity-based compensation, supporting the joint hypotheses that monitoring is more difficult for large firms (Eaton and Rosen 1983; Holthausen, Larcker, and Sloan 1995) and that equity-based compensation substitutes for monitoring (Smith and Watts 1992).

13. Using Q instead of I/K as an explanatory variable of WEIGHT makes the system of equations recursive.

14. Mehran (1995) finds a significant role for the R&D-to-sales ratio, whereas Yermack (1995) finds no relation to the market-to-book ratio.

15. We also consider a proxy for accounting "noise" (standard deviation of return on equity/standard deviation of stock returns) as in Yermack (1995) and Bryan et al. (2000) without material differences in results. The noise proxy has a positive association with WEIGHT as in previous studies.

B. Estimates Based on Data Aggregated over Time

Table 3 contains estimates from the regression of the firm-specific means. In this table, WEIGHT is defined as (mean value of options and restricted stocks during the sample period)/(mean value of total compensation during the sample period). The ratio I/K is computed similarly, whereas the remaining variables are over-time averages of the respective variables. Since all variables are measured as time-series averages, WEIGHT is rarely zero, and thus we employ two-stage least squares rather than two-stage Tobit to estimate equations (4) and (5) jointly.

The estimates from time-series averages support the conclusions drawn from table 2 in all respects, with the exception of CEO stock ownership. For the compensation equation, in particular, the negative coefficient for CEO_HOLD indicates that lower CEO stockholdings are associated with larger equity-based compensation. Mehran (1995) reports a similar finding using a cross section of 153 firms for 1979–90. This result can be interpreted as incentive alignment (Jensen and Meckling 1976) but can also be viewed as an attempt to reduce nondiversifiable risk to the CEO as CEO stock ownership rises.

In columns 2 and 4, WEIGHT is defined as pay-performance sensitivity, computed as the slope coefficient from regressing the change in total CEO compensation (deflated by beginning-of-the-year market value of equity) on stock returns. Since ExecuComp provides a maximum of eight first-differenced observations, the PPS estimates likely contain substantial measurement errors, and thus the associated results need to be interpreted with caution. Furthermore, only 698 firms remain after we require at least five time-series observations for computing PPS. Nevertheless, results indicate that long-term investments are positively related to the equity incentive strength measured by PPS ($\alpha_1 = 71.47$, $t = 3.79$).

C. Results for High-Dividend versus Low-Dividend Firms

One issue often debated in the investment literature is whether the positive coefficient on CASHFLOW is due to financing constraints or to aspects of investment demand not captured by Q. To investigate this issue, we follow the literature and partition the sample into dividend-paying firms (60.5% of the sample) and zero-dividend firms. If the positive coefficient for CASHFLOW is due to binding internal financing constraints, then the relation is more likely to manifest for zero-dividend firms than for mature, dividend-paying firms. On the other hand, if the positive coefficient is due to measurement errors in Q, the CASHFLOW coefficient should not be different.

We display the results in table 4. As predicted, the estimate for CASHFLOW is greater for zero-dividend firms than for dividend-paying firms (0.242 vs. 0.138), and the difference is statistically significant at the level of 0.001 or better. This is consistent with the hypothesis that internal financial constraints are more binding for potentially cash-strapped, zero-dividend firms than for dividend-paying firms. This result reaffirms previous findings (Hoshi et al.

TABLE 3 Two-Stage Least Squares Estimates Using Time-Series Average of WEIGHT and Using Pay-Performance Sensitivity Measures

	Dependent Variable: *I*/*K*				Dependent Variable: WEIGHT		
	Predicted Sign	Sample Average (1)	Pay-Performance Sensitivity (2)		Predicted Sign	Sample Average (3)	Pay-Performance Sensitivity (4)
Intercept		.567	.424	Intercept		−.342	.010
		(9.18)**	(4.67)			(−4.08)**	(5.06)**
WEIGHT	+/−	.262	71.47	*I*/*K*	+	.064	−.001
		(2.64)**	(3.79)**			(3.45)**	(−1.26)
Q	+	.035	.036	CEO_HOLD	−	−.588	−.001
		(4.80)**	(2.89)**			(−7.53)**	(−1.02)
CASHFLOW	+	.147	.251	TENURE	−	−.005	.000
		(9.16)**	(6.62)**			(-7.12)**	(.40)
SALES	+	.016	.009	LIQUID	+	.153	.001
		(14.08)**	(4.45)**			(12.15)**	(2.37)**
				SIZE	+	.039	−.001
						(10.17)**	(−5.13)**
				LEVERAGE	−	−.057	.002
						(−2.11)**	(3.62)**
Observations		2,261	695	Observations		2,261	698
Adjusted R^2		.360	.157	Adjusted R^2		.274	.062

NOTE.—All variables are time-series averages of variables defined in tables 1 and 2 except for the following: For cols. 1 and 3, WEIGHT is (mean equity compensation during the sample period)/(mean total compensation during the sample period); *I*/*K* is (mean investment during the sample period)/(mean of beginning-of-the-year PP&E plus capitalized R&D during the sample period); pay-performance sensitivity (PPS) is the slope coefficient from regressing (change in total CEO compensation/market value of equity) on stock returns using 1992–2000 ExecuComp data. PPS is not estimated if there are fewer than five time-series observations. Each system of equations is estimated using two-stage least squares assuming that WEIGHT and *I*/*K* are endogenous. See tables 1 and 2 for definitions of the variables and descriptions of the estimation procedures. *t*-statistics are in parentheses.

* Significant at the .10 level, two-sided test.

** Significant at the .05 level, two-sided test.

TABLE 4 **Investment Equation Delineated by Dividend-Paying vs. Zero-Dividend Firms**

	Dependent Variable: *I*/*K*	
	Dividend-Paying Firms (1)	Zero-Dividend Firms (2)
Intercept	−.150	−.101
	(−3.20)**	(−.99)
WEIGHT	.924	.770
	(6.98)**	(4.33)**
Q	.039	.047
	(5.83)**	(8.76)**
CASHFLOW	.138	.242
	(10.12)**	(14.23)**
SALES	.013	.017
	(11.76)**	(16.42)**
Adjusted R^2	.205	.205

NOTE.—Zero-dividend firms are those that do not pay dividends in the sample year (39.5% of sample). Remaining firms are dividend-paying firms. The variables are defined in tables 1 and 2. An *F*-test rejects equality of the CASHFLOW coefficients between dividend-paying firms and zero-dividend firms at lower than the 0.001% significance level. An *F*-test cannot reject the coefficient equality for WEIGHT ($p > 48.7\%$). Coefficients for year and industry dummy variables, included in all specifications, are not reported. *t*-statistics are in parentheses.

* Significant at the .10 level, two-sided test.

** Significant at the .05 level, two-sided test.

1991; Fazzari and Petersen 1993) and reinforces the interpretation that both internal financial constraints and compensation structure affect investment spending.

D. Sensitivity Analysis

We conduct additional tests (untabulated) to examine whether results are robust to alternative variable definitions and model specifications. First, specifications in which all variables other than WEIGHT and *I*/*K* are lagged by one period yield comparable results. Second, we reestimate equations by using the instrumental variables method in which instruments are lagged values of all explanatory variables other than WEIGHT and *I*/*K*.[16] These estimations produce results comparable to those in tables 2 and 3. Third, we consider an alternative data source as a basis of an external validity check. More specifically, we replicate our analyses on the survey data compiled by Baber, Janakiraman, and Kang (1996), which contain wider cross sections of firm size for fiscal years 1992–93. Results from the survey data are consistent with those reported in tables 2 and 3.

Finally, it can be argued that the existing *stock* of cash or working capital offers a better proxy for the firm's financing constraints than the *flow* of cash. We examine this proposition by including beginning-of-the-year cash balance

16. There is no guarantee that such an approach, although used in past studies, generates unbiased and efficient estimates. We nevertheless perform these estimations as a second-best solution because of the lack of appropriate instruments.

or beginning-of-the-year working capital in the investment equation. Neither variable is significant at conventional levels, and relations for WEIGHT and CASHFLOW are unaffected by the inclusion of these variables. This result is plausible because, to the extent that issuing debt or equity can increase cash holdings, cash balances are a poor measure of the firm's ability to generate cash internally.

VI. Summary and Conclusions

We evaluate the interaction between corporate investment spending and executive incentive structure (measured by the weight placed on equity-based compensation), where both investments and incentive structure are endogenously determined. Joint estimation of the investment and the compensation models indicates that long-term business investment is significantly related to incentives delivered to top management through equity-based compensation.

The theoretical agency literature assigns a prominent role to appropriately structured executive compensation contracts—especially equity awards to top management—and corporate governance mechanisms in addressing managerial moral hazard with respect to investment. However, the literature is only beginning to explore the empirical influence of agency conflicts and corporate governance on investment decisions (e.g., Mehran et al. 1998). Our study points out that the conventional investment equation based on the *Q* theory (see, e.g., Chirinko 1993) has a missing variable, namely the structure of managerial compensation, which we find is an influential determinant of investment in the presence of agency conflicts. The significant positive correlation between compensation structure and investment is consistent with the prediction that equity-based compensation plays an important role in providing investment incentives to managers. Our study, however, makes no statement on the optimality of investment levels or on whether U.S. managers overinvest or underinvest.

Understanding the determinants of the cross-sectional diversity in compensation structure is an issue of substantial interest. Agency theory predicts that managerial incentive compensation designs are driven by factors that influence the severity of the agency conflicts, such as ownership and the strength of governance mechanisms. We find that the compensation structure is influenced by factors that proxy for the severity of shareholder-manager conflicts. Jointly estimating the investment and compensation equations apparently provides an integrated perspective on the determination of executive compensation structure.

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