## Idiosyncratic Risk and the Manager<sup>\*</sup>

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#### Abstract

Compensating a manager with equity-based pay induces effort but also exposes the manager to firm-specific risk. In comparison to a diversified shareholder, this distorts the manager's discount rate and, in turn, investment and financing decisions. We embed this agency conflict in a structural model of the firm and estimate its effect on firm policies. We estimate the agency friction for a large panel of U.S. public firms and find significant cross-sectional and time-series variation in a manager's incentive to over- or under-invest. Our panel of incentive estimates helps to explain a broad set of empirical patterns, including investment, leverage, cash holdings, valuation ratios, and acquisition activity.

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## 1 Introduction

A nearly universal feature of executive compensation contracts is that they are based largely on the equity value of the firm. Linking an executive's compensation to her firm's performance is generally viewed as an effective way to induce unobservable effort that is personally costly for the manager but increases shareholder value. However, such a contract also necessarily exposes the manager to firm-specific, idiosyncratic risk that cannot be diversified away without undoing the incentive to exert effort. Consequently, while a performancebased contract may induce effort, it may also drive a wedge between the discount rates of diversified shareholders and undiversified managers. The result is that optimal investment, financing, and payout policies from the manager's point of view may differ from those that are optimal for a diversified shareholder. If shareholders are unable to perfectly monitor a manager's policy decisions, one would expect this agency friction to shape firm investment and financing policies observed in the data.

This paper studies the corporate investment and financing distortions that arise as a direct result of the performance-based compensation contracts observed in the data. We embed an agency conflict between a risk-averse manager and shareholders in a neoclassical model of firm investment and financing decisions. The manager is assumed to have control over firm-level policy decisions and shareholders are unable to contract on the manager's selected policies. Given her compensation contract, which consists of stock, options, and a fixed salary component, and the current capital stock and productivity, the manager selects investment and financing policies that maximize her own expected utility. Using firms' financial and executive compensation data, we calibrate the model separately for each firm at each date in our dataset. From the calibrated model, we obtain a panel of estimated investment distortions, measured as the difference in the optimal investment policy of a firm's manager and a diversified shareholder. This allows us to quantify the agency conflict and characterize how it varies across firms and over time.

Firm volatility, a manager's risk aversion, and the components of stock and option compensation interact to produce an agency friction that varies across firms and over time. The friction that we estimate can take positive or negative values, corresponding to a manager's incentive to over- or underinvest, respectively. The estimated mean agency friction in our panel is positive, implying that a manager has incentive to overinvest relative to the case in which this friction were eliminated. This latter case can be thought of as the benchmark investment policy that would be optimal from a diversified shareholder's viewpoint. Specifically, our estimates imply that on average a manager would select an annual investment rate 1.5% points higher than what would be chosen in the absence of the agency friction. Despite this average incentive to overinvest, in nearly a quarter of our observations, the estimated agency friction provides incentives for underinvestment by the manager. Additionally, our estimated investment distortion exhibits significant time variation — the average over-investment incentive dropped by more than 1/3 in the period from 2005 to 2008.

The estimated investment distortion also correlates with a number of firm characteristics. For example, the average distortion varies significantly across industries and the incentive for a manager to overinvest appears stronger for firms with a higher credit rating. Also, we find that firms with stronger corporate governance have managers with less incentive to overinvest than those with weaker corporate governance. We also show that the estimated agency friction helps to predict corporate policies of leverage and cash holding. In the model, managers with an incentive to underinvest behave in a more risk averse manner with respect to firm-specific shocks than would a diversified shareholder. Thus, we would predict managers with an incentive to underinvest to also select conservative leverage and cash holding policies. When we sort managers based on the estimated agency friction, we observe those with the strongest incentive to underinvest have disproportionately high cash holdings and low leverage relative to other firms in the data.

Additionally, we find evidence that our estimates of the agency friction are related to firm valuation. When this friction is positive, the manager effectively has an empire-building incentive as her optimal capital stock is higher than in the case without the presence of agency frictions. With decreasing returns to scale in capital, a larger capital stock corresponds to a lower average or marginal Q and lower valuation ratio. The investment friction that we estimate has significant explanatory power for observed valuation ratios, even after controlling for a number of variables that have been shown to explain valuation.

We then present evidence that changes in the estimated agency friction predict changes in firm-level investment rates observed in the data. This predictive power is both statistically and economically significant and remains even after controlling for previously identified determinants of investment. This suggests that accounting for a manager's incentives for overor underinvestment, resulting from uncertainty and the structure of the compensation contract, can help to explain the dynamics of corporate investment policies.

Finally, we ask whether a manager's overinvestment incentive can help to explain the patterns of acquisition activity in the data. For firms and states where we estimate an overinvestment incentive, one would expect the manager to be more likely to acquire another firm. Using data on acquisition activity, we find evidence that a manager's overinvestment incentive estimated from the model strongly predicts acquisition activity. This effect is present in both levels and changes in a manager's estimated overinvestment incentive. As with the previous empirical patterns, the predictability of our estimated agency friction holds even after controlling for a number of determinants used in the empirical literature on mergers and acquisitions.

Taken together, the evidence outlined above suggests that accounting for distortions induced by a manager's performance-based compensation contract can help to explain a number of corporate policies observed in the data. When a manager's policy decisions cannot be contracted upon, the manager can be expected to choose the policies that maximize her own utility. Such policies need not, and generally will not, coincide with the diversified shareholders' optimal policies. The result is that the policies observed in the data should reflect the personal incentives of the manager. Our empirical evidence indicates that these effects can be quantitatively significant and carry important implications for executive compensation, firm investment and financing decisions, and corporate governance.

Our paper lies at the intersection of the literatures on executive compensation and firm investment and financing decisions. The former is an extensive literature that examines the problem of compensating a manager when effort is unobservable to shareholders. For the most part, the effect of a manager's compensation contract on her chosen investment and financing policies is not considered in this literature. The latter literature in most cases assumes that there does not exist an agency problem between the manager and outside shareholders. Instead, this literature studies the optimal investment and financing policies of a well-diversified manager whose discount rate is identical to that of diversified shareholders.<sup>1</sup>

The idea that incentivizing executives with equity-based pay results in undiversified managers has been previously recognized in the executive compensation literature. Meulbroek (2001) notes that undiversified managers value their own company's stock and options less than the market value determined by diversified investors. She estimates that executives value their option-based compensation between 53% and 70% of its cost to the firm. Hall and Murphy (2002) study the cost, value, and pay/performance sensitivity of executive stock options when these options are held by undiversified, risk averse executives. Similar to Meulbroek (2001), they argue that the distinction between the compensation package's cost to the company and value to the manager is significant. Additionally, Hall and Murphy (2003) note that stock and options are distributed to managers below the top-level executives. Thus, the distortions we study are likely to be present throughout the firm, not just for a handful of individuals.

While the executive compensation literature has noted the costs to a manager of being undiversified, the implications for the manager's policy choices has been mostly unexplored. There are a couple of notable exceptions, however. Lewellen (2006) notes that a manager's exposure to firm-specific risk drives a wedge between the optimal financing policy of the manager and a diversified shareholder. She finds empirically that the volatility costs induced by debt can be significant and help to explain the observed leverage ratios for U.S. firms. Panousi and Papanikolaou (2012) document empirically that firm investment falls in response to a rise in idiosyncratic risk and this effect is increasing in the fraction of insider ownership. They attribute this effect to the undiversified idiosyncratic risk borne by managers that have

<sup>&</sup>lt;sup>1</sup>Strebulaev and Whited (2011) provide a very nice review of the literature studying dynamic models of corporate financing and investment.

incentive-based compensation packages. Danthine and Donaldson (2010) study the optimal contract in a general equilibrium setting where firms are run by risk averse managers and owned by risk averse shareholders. They derive a contract that maintains the incentive for managerial effort while still keeping the manager's pricing kernel in line with that of the diversified shareholders. To achieve this, the manager holds a portion of her own firm's equity as well as a salary that depends on the aggregate wage bill and aggregate dividend. Chen, Miao, and Wang (2010) study the effects of nondiversifiable risk in the context of entrepreneurial firms.

Morellec, Nikolov, and Schürhoff (2012) study agency effects on firm financing decisions. Specifically, they estimate the agency costs of managerial entrenchment in a contingent claims model of firm financing. Nikolov and Whited (2013) estimate a structural model of firm investment and cash holding to infer the degree to which agency frictions affect firm cash holdings. Warusawitharana and Whited (2013) perform a structural estimation to study the effect of misvaluation shocks on a firm's financing and investment policies.

In this paper, we take the executive compensation contracts observed in the data as given. We remain silent on whether these contracts are optimal from the viewpoint of shareholders. Rather, we are interested in how the observed contracts affect a manager's optimal investment and financing decisions. In contrast, a large literature studies these agency conflicts in an optimal contracting framework.<sup>2</sup>

## 2 Model

We develop a neoclassical production model of the firm which embeds a simple agency conflict between the manager running the firm and outside equity holders. We assume that managers have control over the investment decisions of the firm, and make these decisions in response to the incentives provided by their compensation contracts. The model is silent as to how these contracts are determined, but rather takes these contracts as given and describes the

<sup>&</sup>lt;sup>2</sup>See, for example, DeMarzo and Sannikov (2006), DeMarzo and Fishman (2007), DeMarzo, Fishman, He, and Wang (2012), Edmans, Gabaix, and Landier (2009), and Edmans, Gabaix, Sadzik, and Sannikov (2012).

investment policy decisions we would expect to see on the part of the manager.

Firm subscripts are suppressed, and we adopt recursive notation throughout where the ' superscripts denote next period values.

#### 2.1 Firm Production and Investment

Firms produce using physical capital, k, subject to stochastic productivity, z. The firm's profits are given by

$$\pi(k,z) = zk^{\alpha} - f \tag{1}$$

where f represents a fixed operating cost. We assume decreasing returns to scale in production, which implies  $\alpha < 1$ . A firm's idiosyncratic productivity, z, evolves according to

$$\log(z') = \rho \, \log(z) + \sigma \epsilon' \tag{2}$$

where  $\epsilon$  is drawn from the standard normal distribution. Each firm is able to scale its operations through changes in its capital stock, k. This physical investment expenditure, i, obeys the capital accumulation constraint

$$i = k' - (1 - \delta)k \tag{3}$$

where  $\delta > 0$  represents the per period depreciation rate of capital. Investment is subject to adjustment costs of a quadratic form given by

$$\Phi(i,k) = b\left(\frac{i}{k} - \delta\right)^2 k.$$
(4)

#### 2.2 Financing and Taxes

Each firm's capital investment, as well as any distributions to shareholders, can be financed from two sources: internal funds resulting from operating profits or by raising additional external equity. We assume that raising external equity entails a proportionate cost on the size of the equity issuance e:

$$\Lambda(e) = \lambda e \tag{5}$$

where  $\lambda \geq 0$ .

The firm pays corporate income tax on earnings after deducting depreciation at a rate  $\tau_c$ , and equity payouts are taxed at a personal rate of  $\tau_d$ . The firm's net cash flows are

$$D(i,k,z) = (1 - \tau_c)\pi(k,z) + \tau_c \delta k - i - \Phi(i,k)$$
(6)

which correspond to equity issuance when D is negative. Finally, after accounting for any equity issuance costs, the after-tax value of the dividend is

$$d(i,k,z) = (1 + \mathbb{1}_{[D<0]}\lambda - \mathbb{1}_{[D>0]}\tau_d)D(i,k,z)$$
(7)

#### 2.3 Value of the Firm

In the absence of agency conflicts, the investment policy is chosen to maximize the value of the firm, V(k, z). Specifically, the investment policy rule solves the following optimization:

$$V(k,z) = \max_{i} \left\{ d(i,k,z) + \beta \mathbb{E} \left[ V(k',z') \,|\, k,z \right] \right\}$$
(8)

where

$$i = k' - (1 - \delta)k.$$

Denote as  $i^*(k, z)$  and  $V^*(k, z)$  the investment policy function and value function which satisfies this maximization.

When the manager controls investment decisions, the implemented investment policy can deviate from  $i^*(k, z)$ , which is what we explore next.

#### 2.4 Manager Compensation

Because of the complexity of investment decisions, shareholders delegate these decisions to managers inside the firm. Managers make decisions based on the compensation contracts they are given: in order to induce costly effort, shareholders provide compensation tied to the outcome of the firm. However, this also means that the incentives of the manager in terms of risk-taking and investment policy may deviate from what is first-best optimal for the shareholder. The manager derives value from the firm distinct from the shareholder. Specifically, the manager derives utility from the compensation she is awarded. Her compensation contract is defined by  $\Theta \equiv \{\theta_s, \theta_o, F\}$ , where  $\theta_s$  is stock compensation,  $\theta_o$  is option compensation, and F is fixed salary. The manager has constant relative risk aversion (CRRA) preferences:

$$U(c) = \frac{c^{1-\gamma}}{1-\gamma}.$$
(9)

In order to understand how the manager's investment policy deviates from the investment policy which maximizes shareholder value, we employ the following "experiment:" if we allowed the manager to takeover the firm for one period, what investment decision would she make? The precise timeline of events is as follows. At time t, the manager is given shares and options in the amount  $\theta_s$  and  $\theta_o$ . Faced with a current capital stock k and productivity z, the manager makes an investment decision which determines next period capital stock k'as well as the current period dividend d. The manager receives her share of this period's dividend,  $\theta_s d$ , and invests this at the risk free rate. In the next period, t+1, the productivity shock z' is realized and the manager receives utility over the consumption of the previous period's dividend and the equity and option compensation based on the cum-dividend equity value as of t+1, plus any fixed salary. Thus the manager receives cash flows at time t and t+1, but we assume it is all consumed at t + 1. Given that we are focused on a single investment decision, the manager simply needs to maximize her expected utility over compensation:

$$\max_{k'} \mathbb{E} \left[ U(C(k', z', k, z)) \right] \tag{10}$$

where

$$C(k', z', k, z) = (1 + r_f)\theta_s d(i, k, z) + F + \theta_s V^*(k', z') + \theta_o \max(V^*(k', z') - S(i, k, z), 0), \qquad (11)$$
$$i = k' - (1 - \delta)k$$

and S(i, k, z) is the strike price on the manager's option compensation. In practice, most options are issued at a strike price equal to the current price (at the money), and we therefore make the assumption that the strike price is the ex-dividend equity value at time t:

$$S(i,k,z) = V^*(k,z) - d(i,k,z).$$
(12)

Using the ex-dividend equity value as the strike price means that the option is dividend protected, and thus the presence of option compensation won't mechanically drive the investment and dividend policy of the manager. Note that the strike price depends only on time t variables.

Given the utility maximization problem in (10), we can define  $i(k, z \mid \Theta)$  as the manager's investment policy which maximizes her utility.

#### 2.5 Investment Friction

We have now defined the first-best optimal investment rate for the shareholder,  $i^*(k, z)/k$ , and the optimal investment rate for the manager,  $i(k, z | \Theta)/k$ , which allows us to define the overinvestment incentive of the manager as the difference in the investment rates:

$$\omega_0(k, z \mid \Theta) = \frac{i(k, z \mid \Theta) - i^*(k, z)}{k} \,. \tag{13}$$

Positive values for  $\omega_0$  indicate that the manager chooses a higher investment rate than what the shareholders would prefer (e.g. empire building), and negative values indicate a lower than optimal investment rate (e.g. risk avoidance).

In addition, given the wedge between the investment decision of the manager and the shareholder optimal investment, we can calculate the one-period expected wedge in firm value:

$$\nu(k, z) = [d(i^*(k, z), k, z) - d(i(k, z | \Theta), k, z)] + \mathbb{E} [V^*(k^{*\prime}, z') - V^*(k'_{\Theta}, z') | k, z]$$
(14)

where

$$k^{*\prime} \equiv i^{*}(k, z) + (1 - \delta)k$$
$$k_{\Theta}^{\prime} \equiv i(k, z \mid \Theta) + (1 - \delta)k$$

## 3 Calibration and Quantitative Results

By calibrating and simulating the model, we are able to quantify the magnitude of the agency friction on firm investment. Additionally, by estimating the overinvestment incentive for a panel of firms, we can study how this agency friction relates to policies and characteristics of firms in the data.

#### 3.1 Data Description

To calibrate the model, we collect data on executive compensation, financial statements, and equity returns for a sample of US public companies. Specifically, we gather data on salary and equity and option ownership stakes for CEOs listed in the Execucomp database. This database provides compensation data for a subset of executives of US public companies at an annual frequency for the period 1992–2012. We supplement these data with firm financial data from the annual Compustat database. Data on industry segments also comes from Compustat. Monthly equity returns for the corresponding firms are collected from the CRSP database.

Additionally, we collect data on acquisition activity. Acquisition data is from SDC Platinum, and we categorize a firm as an acquirer if they announced one or more acquisitions with a transaction value of at least \$50 million (in real 2000 USD) during the fiscal year. Both public and private target firms were considered, but the acquisition had to be for at least a 50% stake of the target firm.

Finally, we collect data on a firm's measure of corporate governance. We use the governance index constructed by Gompers, Ishii, and Metrick (2003), which provides a governance score for a sample of U.S. public firms during the period 1993–2006. The data and further information are provided at Andrew Metrick's website.<sup>3</sup>

The firms contained in the Execucomp database represent a subset of the firms available in the Compustat annual database. As we require data on a CEO's compensation contract at the firm level, our sample is restricted to those listed in the Execucomp data. After

 $<sup>^3\</sup>mathrm{See}\ \mathtt{http://faculty.som.yale.edu/andrewmetrick/data.html}$ 

applying a set of standard filters used in the empirical corporate finance literature we end up with an unbalanced panel spanning 1992–2012, consisting of 1,525 distinct firms and 18,595 firm-year observations.<sup>4</sup>

#### **3.2** Calibration and Estimation of Model Parameters

We now describe the calibration and estimation of parameters of the model. Table I lists the parameter values and distribution statistics for those parameters that vary across firms or over time.

We first estimate the returns to scale on capital,  $\alpha$ , the persistence of firm productivity shocks,  $\rho$ , and firm productivity residuals, using the approach of Olley and Pakes (1996). The depreciation rate of capital is set by computing the average ratio of the depreciation expense to net property, plant, and equipment, as reported in Compustat, for the firms in our sample. This gives an annual depreciation rate of  $\delta = .091$ , a value in line with previous estimates used in the literature. We choose values for the capital adjustment cost parameter, b = 0.5, and cost of external financing parameter,  $\lambda = 0.02$ , to be consistent with values used in the existing literature on dynamic models of firm investment and financing.

A manager's compensation contract is defined by three parameters: stock compensation  $(\theta_o)$ , option compensation  $(\theta_o)$ , and fixed pay (F). We calibrate these values for each period and firm in our sample using data on CEO compensation contracts from Execucomp. The stock compensation,  $\theta_s$ , is set equal to the shares owned by the CEO, excluding options, divided by the common shares outstanding. For option-based compensation, we use the CEO's unexercised options that are exercisable as reported in Execucomp. Thus,  $\theta_o$  is this measure of options divided by the firm's common shares outstanding. Finally, we follow Dittmann and Maug (2007) in calibrating the fixed pay component of the contract. Specifically, we define fixed pay as the sum of the following five variables in Execucomp: Salary, Bonus, Other Annual Compensation, All Other Total Compensation, and Long-term Incentive Pay.

<sup>&</sup>lt;sup>4</sup>For example we remove firms with negative book assets, negative sales, negative gross property, plant, and equipment.

firm's capital stock to calibrate the parameter F.

The fixed costs of production f is an important parameter to determine firm profitability, valuation ratio, and frequency of external financing. We allow this parameter to vary across firms and over time using the following calibration. For each firm-year, the model is solved with no fixed costs, and the firm cashflows are simulated. We choose f for the final parameterization to be the 10th percentile of the cashflows simulated, meaning that 10% of the cashflows would be negative after paying the fixed costs. This corresponds roughly to the 10% equity issuance frequency reported in Hennessy and Whited (2005).

We would like to have an annual measure of the volatility of productivity  $\sigma_{it}$ , however accounting data is not reported frequently enough for us to measure this directly. Instead we estimate the relationship between  $\sigma_{it}$  and equity volatility, leverage, and other controls, and use the predicted values from that estimate to construct an annual estimate of  $\sigma_{it}$ .

Specifically, we take the panel of firms for which we have estimated productivity as described above and divide the panel into two non-overlapping periods: 1992–2002, and 2003–2012. Within each group  $\tau$  and for each firm *i* we estimate the standard deviation of the productivities,  $\sigma_{i,\tau}$ , and the time-series mean of control variables  $X_{i,\tau}$ . Within each group  $\tau$  we estimate the cross-sectional regression:

$$\sigma_i = b' X_i + \alpha_j + \gamma_t + \epsilon_i \,, \tag{15}$$

where  $\alpha_j$  and  $\gamma_t$  are industry and year fixed effects. We then construct our proxy for the annual measure of the volatility of productivity as the predicted value from this regression:

$$\widehat{\sigma_{it}} = \hat{b}' X_{it} + \hat{\alpha}_j + \hat{\gamma}_t \,. \tag{16}$$

Included in X is equity volatility, leverage, log of firm age, and log of total assets. The market-to-book ratio was not included because it did not enter significantly in the estimation. We require firms to have at least 5 observations of productivity to be included in the cross-sectional estimation, but we generate  $\widehat{\sigma_{it}}$  for all firms in the sample. We winsorize below at the 5% level which eliminates negative estimates of  $\widehat{\sigma_{it}}$ . The estimated panel of  $\widehat{\sigma_{it}}$  are very similar using a either a finer grouping or estimating over the entire sample.

We are interested in quantifying the investment friction conditional on the firm's volatility,  $\sigma$ , and the manager's compensation contract  $\Theta$ . Let  $\omega(\sigma, \Theta)$  be the expected investment friction:

$$\omega(\sigma, \Theta) = \mathbb{E}[\omega_0(k, z | \sigma, \Theta)]$$
(17)

which is estimated as the average  $\omega$  over a long simulation of the firm.

We use Compustat and ExecuComp data to construct a panel of  $\sigma_{it}$  and  $\Theta_{it}$ , and use this to construct a panel of investment frictions:

$$\omega_{it} \equiv \omega(\sigma_{it}, \Theta_{it}) \tag{18}$$

The final estimates of  $\omega_{it}$  are winsorized at the 1% level.

## 4 Characterizing the Agency Friction

In this section, we present summary statistics of the investment friction,  $\omega_{it}$ , and examine how our estimates relate to characteristics of the firm and CEO. We estimate an overinvestment incentive,  $\omega_{it}$ , at each date for each firm in our sample. In Figure 1, we plot the distribution of the estimated panel of  $\omega_{it}$ . Additionally, we present moments of this distribution in Table II. The mean overinvestment incentive in our sample is about 1.5%. In other words, on average, a firm in our sample has a contract that incentivizes the manager to select an investment rate that is 1.5 percentage points higher than what would be optimally selected by a diversified shareholder. In our sample, the average annual investment rate is 9%, suggesting that the manager is incentivized to select an investment rate that is on average about 17% larger than in the case where the agency friction on investment was eliminated. From this perspective, our estimated agency friction on investment is economically significant.

Figure 1 shows that there is significant variation in the estimated values of  $\omega_{it}$  and not all values are positive. In fact, 23% of the observations are values less than zero, implying that in those states the manager has an incentive to *under*-invest, relative to the benchmark with no agency frictions. The estimated  $\omega_{it}$  vary both across firms and over time. This underscores the importance of using a quantitative, dynamic model in estimating this agency conflict.

In Figure 2, we plot the time series of the cross-sectional average of the  $\omega_{it}$  estimated in our sample. The average overinvestment incentive is positive for all years in our sample, however, it displays significant time variation. The average overinvestment incentive peaks in 2005 at a value just over 1.8%. The minimum average  $\omega_{it}$  in our sample occurs three years later, in 2008, with a value of 1.1%. That is, the average overinvestment incentive dropped by more than 1/3 in a span of three years.

We now examine how the estimated  $\omega_{it}$  relate to characteristics of the firm and CEO. In Table III, we present summary statistics for the estimated overinvestment incentive by industry. We use the Fama-French 17 industry classification, based on a firm's SIC code.<sup>5</sup> The table reports the mean, standard deviation, and quartiles of the estimated  $\omega_{it}$  by industry. Our estimates indicate a significant amount of heterogeneity in the mean and median estimated  $\omega_{it}$  across industries. In particular, the Oil and Steel industries display relatively low overinvestment incentives, while we find stronger overinvestment incentives for the Drug and Chemical industries.

Table IV reports the mean and median overinvestment incentive by credit rating. The credit ratings refer to long-term corporate debt ratings supplied by S&P and collected from the Compustat database. We note a clear monotonic pattern where the estimated  $\omega_{it}$  are increasing with a firm's credit rating. Not only is this pattern momontonic for both the mean and median, there is significant dispersion in these across credit ratings. For example, AAA firms have a mean estimated  $\omega_{it}$  of nearly 2.5%, while this value for BB firms is just under 1.5%. The firms with the lowest credit rating in our sample, those with a CC rating, have an average  $\omega_{it}$  of -1.05%. That is, the managers of these firms on average have an incentive to underinvest relative to the policy of a diversified shareholder.

To explore how the incentive measure changes over time within the firm, we construct Figure 3 which plots average  $\omega_{it}$  in event time. Each calendar year, firms are quartiles based on  $\omega_{it}$ . These bin assignments are retained for the subsequent ten years and the average  $\omega_{it}$ for each bin is calculated in each of these event years 0-10. This is repeated for every calendar

<sup>&</sup>lt;sup>5</sup>More information on the Fama-French industry classification can be found at Ken French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data\_library.html

year 1992-2002, which generates 11 averages for each quartile. Within each quartile, the 11 averages are averaged, and this quartile average is plotted in event time. Dashed lines show the 95% confidence intervals for each quartile.

Figure 3 shows that there is noticeable mean reversion, but that even after 10 years there is still a significant difference between the high and low quartile. It is useful for our empirical tests that  $\omega_{it}$  is not akin to a firm fixed effect, and it does appear to exhibit time variation. In fact, the autoregressive coefficient of  $\omega_{it}$  on its first lag is 0.78, and 0.55 when firm fixed effects are included. Figure 4 repeats the exercise but attempts to control for potential survivorship bias problems by requiring the firm to have at least 10 years of future data in order to be included in the quartile average for that year. This prevents firms that drop out of the sample from impacting the results. The results are very similar.

It is informative to relate the incentive measure  $\omega_{it}$  to the underlying parameters which determine it, specifically volatility of productivity  $\sigma$ , and the compensation contract terms  $\theta_s$  and  $\theta_o$ . Figures 5, 6, and 7 provide scatter plots relating the panel of investment incentive estimates,  $\omega_{it}$ , with volatility and the contract terms. In each case the general relationship between these parameters and the incentive estimate are as we would expect. It also interesting to note that the relationship between the parameters and the estimates appears highly non-linear.

For volatility, shown in Figure 5, the incentive to overinvest trends down for higher levels of volatility. As the value of the firm becomes more uncertain, the manager becomes more risk avoidant and chooses to invest less in the risky production assets within the firm. Also note that for very low levels of sigma, very few managers have an incentive to underinvest: as the cash flows become certain, the manager has less incentive to avoid the idiosyncratic risk of the firm.

For stock compensation  $\theta_s$ , shown in Figure 6, the overinvestment incentive is generally trending lower for higher levels of stock compensation. Higher stock compensation means that even idiosyncratic risk dramatically impacts the manager's consumption, and thus the manager is highly risk averse over even idiosyncratic shocks. To avoid this risk, a manager with a high level of stock compensation chooses a lower level investment. This trends in the opposite direction of option compensation, shown in Figure 7, which provides a downside-protected payoff to the manager. Because of the convexity of option compensation, idiosyncratic risk can actually increase the manager's expected utility.

#### 4.1 Corporate Governance

In Table V we report summary statistics for  $\omega_{it}$  sorted into groups based on a firm's measure of corporate governance. Specifically, we construct five bins according to a firm's corporate governance measure constructed by Gompers, Ishii, and Metrick (2003).<sup>6</sup> Group 1 of the table consists of firms with a high measure of corporate governance (low GIM g score) and Group 5 consists of firms with a low measure of governance. The table illustrates a monotonic relationship where the estimated overinvestment incentive is decreasing with a firm's corporate governance measure. In other words, this implies that firms with lower corporate governance tend to have compensation contracts that incentivize overinvestment by the manager.

#### 4.2 Firm Characteristics

In order to further characterize the overinvestment incentive, we run panel regressions of the estimated  $\omega_{it}$  on a set of firm and CEO variables. The results of these regressions are presented in the six columns of Table VI. In each regression, the dependent variable is  $\omega_{it}$ measured in percentage points. Columns (1)–(3) use the same set of firm and manager characteristics but differ in their use of fixed effects. Columns (4)–(6) are analogous to the first three but include binary variables for low and high measures of the Gompers, Ishii, and Metrick (2003) governance index. Due to the limited availability of g scores for the firms and dates in our data, including these variables eliminates more than half of the observations in our sample.

<sup>&</sup>lt;sup>6</sup>We use the Gompers, Ishii, and Metrick corporate governance index data, provided by Andrew Metrick at his website: http://faculty.som.yale.edu/andrewmetrick/data.html. Details of the construction of the g index can be found in Gompers, Ishii, and Metrick (2003).

The estimated overinvestment incentive is positively related to a firm's book assets and profitability and displays a negative relationship with asset tangibility and a firm's cash/assets ratio. Across firms, R&D displays a positive relationship with the overinvestment incentive. However, when we control for firm-level fixed effects, we see that the within-firm variation in R&D has a negative relation and becomes statistically insignificant. Additionally, the coefficient on Selling, General, and Administrative Expense is positive and statistically significant, except when we control for firm fixed effects, in which case it becomes statistically insignificant.

In addition to characteristics of the firm, we include characteristics of the CEO in the panel regressions in Columns (4)–(6) of Table VI. A CEO's age appears to have a statistically insignificant effect. However, the length of a CEO's tenure has a strongly negative relationship with the overinvestment incentive. This negative relationship holds both across firms and for within-firm variation. This suggests that a manager who has served as a company's CEO for a longer period of time tends to have less of an incentive to overinvest.

Finally, we construct two measures of firm governance, based on the GIM index, to include in the regression. The variable "Low g score" is a binary variable equal to 1 for firms in the lowest g index quintile and zero for firms with a g score that is not in the lowest quintile. The GIM index is inversely related to a firm's governance, so firms with a low g score are those that have a high measure of governance. The "High g score" variable is an analogous binary variable for firms in the highest quintile of g scores. The indicator for a low g score correlates with firms that have a lower  $\omega_{it}$ . In other words, the overinvestment incentive that we estimate appears to be negatively related to a firm's quality of corporate governance. Also, we see a similar result with the indicator for a high g score. While not statistically significant, the estimated coefficient indicates that a low level of corporate governance corresponds to a larger overinvestment incentive for the manager. These results for the relationship between corporate governance and estimated  $\omega_{it}$  are also consistent with the previously discussed pattern in Table V.

#### 4.3 Relation to Leverage and Cash Holdings

We now examine more closely the relationship between the estimated agency friction and a firm's financing policies. Specifically, we look at how  $\omega_{it}$  relates to cash holdings and leverage. While these policies are outside the scope of our model, the agency friction that we estimate is likely to influence a number of corporate policies in addition to capital investment decisions. For example, the same incentives that would lead a manager to underinvest relative to shareholders would also lead her to choose a lower leverage ratio. In states where the manager's marginal utility is high, she applies a higher discount rate to future firm cash flows than the diversified shareholders. With a higher discount rate, the optimal capital stock for the manager is smaller than that for the shareholder. Moreover, a higher discount rate also implies a lower optimal leverage ratio for the manager. Again, although this is outside the model, it can be viewed as a prediction for how a firm's leverage should relate to our estimated  $\omega_{it}$ . Interestingly, Figure 10 shows some support for this prediction.

We first sort firm-dates into deciles based on their estimated  $\omega_{it}$ . We then compute a median book leverage ratio for each decile and plot these in Figure 10. Decile 1 corresponds to firm-dates with a low estimated  $\omega_{it}$ . For deciles 4 and higher, the median book leverage by decile remains relatively flat at around 20%. However, for the lowest deciles, the median book leverage is significantly lower. For example, the first decile has a median book leverage of about 7%, which is significantly smaller than the unconditional median of about 20%. Moreover, the median book leverage for the first  $\omega_{it}$  decile is only about half as large as that for the second decile. A very similar looking pattern obtains for the mean book leverage ratio of each decile.

In Figure 11 we present an analogous set of results for firms' cash/assets ratios. Again, we assign firm-date observations to a decile according to the estimated  $\omega_{it}$ . We then compute and plot the median cash/assets ratio for each decile. As with the book leverage plot in Figure 10, here again we see a striking difference in cash holdings for those firms with a manager who has a low  $\omega_{it}$ . The median cash to assets ratio among all firms in our sample is about 9%. However the median of the first  $\omega_{it}$  decile is nearly 20%. Like book leverage, a

choice of cash holdings is not in our model. However, the agency friction that we estimate naturally has predictions for the amount of cash a manager would choose to hold. The managers in the first decile have a median  $\omega_{it}$  of -1.5%. That is, they have an incentive to choose an investment rate 1.5 percentage points below what would be optimally chosen by a diversified shareholder. With less incentive to invest, the manager is spending less funds on capital. The alternative, then, is to either retain these funds as cash or distribute them. Thus, we would predict a manager with a negative  $\omega_{it}$  to adopt higher cash holdings, all else equal. Indeed, this is what we observe in Figure 11 when comparing the median cash holdings of the first decile to the other deciles. Again, we find a very similar pattern when using the mean cash holdings for each decile.

## 5 Implications for Firm Investment Policy

Our panel of estimates measures the degree to which managers have an incentive to overor underinvest relative to what would be optimal if agency frictions did not exist. Because the firm is always run by the manager, at any point in time the capital stock reflects the history of past investment decisions by the manager. This means that while the agency distortion may exist, it may not directly impact investment rates. For example, if the manager prefers a capital stock 10% higher than without the friction, at any point in time the capital stock would be 10% above the unobservable counterfactual, but investment rates would be equivalent to this counterfactual. Therefore, when we relate our distortion measure to the data, we cannot look directly at the relationship between observed investment rates and  $\omega_{it}$ . Instead, we generate several implications of this investment friction and test them in the data.

#### 5.1 Impact on Valuation

Although our friction does not necessary predict differences in investment *rates* across firms, it could have implications for capital stock *levels*. One of the most straightforward tests of this is to look at how our friction relates to valuation, specifically Tobin's, or average, Q. With decreasing returns to scale, firms have an optimal scale, and deviations from that optimal scale impact Q:

$$\frac{\partial q}{\partial k} = \frac{\partial \left(\frac{V}{k}\right)}{\partial k} < 0.$$
(19)

Therefore, we expect to see a negative relationship between our measure of overinvestment incentive,  $\omega_{it}$ , and the firm's valuation ratio.

Table VII reports the results of a panel regression of Q on an indicator variable for an empire-building incentive,  $\omega_{it} > 0$ , as well as various controls, and time, industry, and firm fixed effects. The baseline controls include log assets, whether the firm paid a cash dividend in the current year, and the ratio of R&D to assets. These were chosen following Lang and Stulz (1994) which identifies each of these controls as being important in determining Q.

The coefficient on the overinvestment incentive dummy is statistically significant and economically large: in the specification in Column (3), which most closely replicates that used in Lang and Stulz (1994), firms run by managers with empire building incentives have a Q which is 0.29 lower. For the median firm, that corresponds to about a 23% reduction in its valuation ratio. The effect remains significant and large even for within firm variation in  $\omega_{it}$ : the coefficient is -0.17 when firm fixed effects are included, reported in Column (5).

Columns (2), (4), and (6) report results when equity volatility and total incentive pay, measured as the sum of  $\theta_s$  and  $\theta_o$ , are included in the regression. Both of these variables are important in the estimate of  $\omega_{it}$ , but we find that it does very little to change the coefficient on  $\omega_{it}$ , and in Columns (2) and (4) actually strengthens the result. It does not seem to be the case that a subset of low-growth, low-incentive-pay firms are driving the results.

Table VIII performs the same set of regressions but uses the continuous variable  $\omega_{it}$ in place of a binary variable. As in Table VII, the results are significant and quite large: according to Column (3), a one standard deviation increase in  $\omega_{it}$  corresponds to a Q which is 0.10 lower. This provides further evidence that the investment incentive friction is strongly related to valuation.

Given that the reduction in Q associated with an overinvestment incentive is of similar magnitude to the diversification discount documented in Lang and Stulz (1994), it is natural to investigate the relationship between diversification and our incentive measure. If managers have a strong incentive to empire build (high  $\omega_{it}$ ), this may lead to expansion into segments outside of the firm's focus, thus leading to diversification. On the other hand, a manager which has a strong incentive to avoid risk (low  $\omega_{it}$ ) may seek diversification to lower the firm's asset volatility. These effects work in opposite directions, so it is difficult to form an expectation for the relationship between diversification and the investment incentive  $\omega_{it}$ .

Table IX investigates this relationship. The first two columns regress  $\omega_{it}$  on a dummy variable indicating diversification: this variable is 1 if the firm operates in more than one segment, and 0 otherwise, where a segment is defined as a line of business comprising at least 10% of the firm's revenues. Both with and without year and industry fixed effects, the coefficient on the diversification dummy is positive and significant: diversification correlates with an investment incentive higher by 16 basis points, after controlling for year and industry effects.

Columns (3)–(5) repeat the Lang and Stulz (1994) Q regressions of Table VIII but show the effect of diversification. Column (3) recreates the result found in Lang and Stulz (1994), in which diversification corresponds to a 0.27 lower Q. Column (5) includes both the diversification dummy and  $\omega_{it}$ , and reveals that their individual ability to explain Q is almost completely unchanged. This suggests that while diversification and manager incentives are positively related, they each have strong independent ability in explaining valuation.

#### 5.2 Changes in Investment Policy

As discussed earlier, the agency distortion will effect the level of capital stock chosen by the manager, but not necessarily the investment rate. This is because the manager's past incentives have impacted past investment decisions. However, we might still expect a change in incentives to result in a change in investment policy.

Table X reports the regression results in a predictive regression for the change in investment. Columns (1) and (3) use standard predictors of investment, lagged changes in Q and cashflow, as well as lagged changes in our measure of investment incentives,  $\omega_{it}$ , with and without firm fixed effects. The coefficients are significant and close to one, which has the convenient interpretation that if overinvestment incentives increased by 1 percentage point, this corresponds to a 1 percentage point increase in the current investment rate. This is the coefficient that the model predicts.

One-year changes in incentives may be a fairly noisy measure, so we also run the regression with the level of investment incentives of the manager,  $\omega_{it}$ , reported in Column (2) and (4). The estimates are quite similar, and the coefficient is almost exactly equal to one when we include firm fixed effects. As we might expect if  $\Delta \omega_{it}$  were a noisy measure, the results are even more significant when we use  $\omega_{it}$ .

Finally, to avoid concerns that changes or levels of investment incentives predict changes in investment because they are correlated with other firm characteristics, Columns (5) and (6) include eight controls of characteristics that have been found to predict investment.<sup>7</sup> These controls include the levels and changes in Q, cashflow, equity volatility, equity returns, log of capital, as well as year and firm fixed effects. Even with all of these controls, including volality, which is an important component of  $\omega_{it}$ , the coefficient on incentives is still economically large at about 0.5. Although the coefficient on  $\Delta \omega_{it}$  becomes significant only at the 10% level, the coefficient on  $\omega_{it}$  remains significant at the 1% level.

#### 5.3 Acquisition Activity

The decision to acquire another firm is one of the largest investment decisions a firm can make. However, whether all acquisitions are motivated by a desire to maximize shareholder value is by no means clear. For example, Moeller, Schlingemann, and Stulz (2005) find that, in aggregate, acquirers lost \$240 billion in equity value between 1998 and 2001 around acquisition announcements, which is 12% of the total amount spent on these acquisitions. There is a large literature, both theoretical and empirical, which shows that agency conflicts may play an important role in acquisition decisions. For example, Jensen (1986) suggests that a manager may waste free cash by over investing, and Harford (1999) provides empirical

<sup>&</sup>lt;sup>7</sup>See Panousi and Papanikolaou (2012).

evidence that this agency conflict impacts the acquisition decision.

We find evidence that the incentives of the manager predict acquisition activity. We estimate a logit regression where the dependent variable is equal to 1 if the firm announces an acquisition in the next year, and 0 otherwise. Firms in our sample announce acquisitions in about 4.8% of years, for a total of 884 acquisitions. We include the manager's investment incentive estimate,  $\omega_{it}$ , as well as other controls. The results are reported in Table XI. Consistent with manager incentives impacting acquisition activity, Column (1) shows that  $\omega_{it}$  is strongly significant in predicting acquisition activity. This holds, both is significance and magnitude, in Columns (3) and (5) which include various controls and year and industry fixed effects. Controls include an industry wave indicator variable which is 1 when the firm is in an industry which is undergoing a wave; the construction of this wave variable follows Harford (2005). Also included as controls are the firm's Q, cash flow, log of market value of equity, and equity returns over the previous year, variables indicated by Harford (2005) and Palepu (1986) as important in the M&A market.

In addition to finding the manager's investment incentives to predict acquisition activity, we also find that changes in a manager's incentives impact the acquisition decision. This result is shown in Columns (2), (4), and (6). This means that an increase in the investment incentive of the manager predicts subsequent acquisition activity.

#### 5.4 Steady state

Thus far we have focused on the manager's one-period investment decision and its deviation from the first-best optimal. While this provides a convenient measure of the agency friction, it would be useful to understand how this one-period deviation translates into the capital stock *level* for a firm in which the manager makes investment decisions every period. We do this by iterating on the manager's investment policy function to find the steady state level of capital stock the manager would choose given the state z, and compare this to the steady state level of capital stock that would be chosen without the agency friction.

Recall from Section 2.5 that, conditional on being in state (k, z), the manager chooses an

investment of  $i(k, z, |\Theta)$ . This means that the next period level of capital is  $k' = i(k, z |\Theta) + (1 - \delta)k$ . This was all that was necessary to construct the one-period investment friction as we did in Section 2.5. However, given the new level of capital k', it is natural to ask, how much would the manager invest? If z is unchanged, the manager chooses  $i(k', z, |\Theta)$ , which gives  $k'' = i(k', z |\Theta) + (1 - \delta)k'$ . We can continue to interate on the manager's investment decisions until we reach the steady state level of capital, which we define as  $k_{ss}(z |\Theta)$ . This is the optimal level of capital the manager would choose for the firm in state z.

We can perform the same iteration for the investment policy without agency frictions,  $i^*(k, z)$ , to get the steady state level of capital  $k^*_{zz}(z)$ . The the ratio of these two levels,

$$\frac{k_{ss}(z \mid \Theta)}{k_{ss}^*(z)}, \qquad (20)$$

represents the proportion to which we would expect the level of the capital stock of a firm run by a manager to deviate from the first-best optimal capital stock. Just as with  $\omega$ , we can take expectations for each firm-year parameterization and generate a panel of these capital stock ratios. A histogram of these values are shown in Figure 8. Values greater than one indicate overinvestment or empire building, and values less than one indicate underinvestment or risk avoidance.

Given these steady state capital stock levels, we can also calculate the relative firm size at the steady state capital levels:

$$\frac{V^*(k_{ss}(z \mid \Theta), z)}{V^*(k_{ss}^*(z), z)}.$$
(21)

Similarly, we can take expectaions for each firm-year parameterization and construct a panel of these value ratios, which are shown in Figure 9. Note that this ratio of firm values does not measure value loss from the agency, but simply the relative equity values of firms at capital levels chosen by the manager relative to first-best capital choice.

## 6 Conclusion

This paper starts with the observation that most executive compensation contracts observed in the data require a manager to hold significant exposure to their firm's idiosyncratic risk. While this is generally viewed as an effective way to induce costly, unobservable effort from the manager, it also has the effect of distorting a manager's pricing kernel relative to that of a diversified shareholder. This misalignment naturally creates a distortion in the manager's chosen investment and financing policies.

We embed this agency friction in a structural model of firm investment and estimate its effect on firm policies. Using the model, we are able to estimate the agency friction for a large panel of U.S. public firms over the period 1992-2012. We find significant variation, both across firms and over time, in a manager's incentive to over- or under-invest. We show that these estimated incentives correlate with a number of firm characteristics, such as industry, credit rating, and measured corporate governance. Additionally, we show that manager's with an estimated under-investment incentive have disproportionately higher cash holdings and lower leverage, consistent with our predictions. The panel of estimated agency conflicts also has significant explanatory power for firm investment, valuation ratios, and acquisition activity.

In total, our empirical results suggest that the panel of estimated agency conflicts carries important information for a range of firm investment and financing policies. We conclude that this explanatory power is novel in that it appears to be uncorrelated with previously identified determinants. This suggests that accounting for the distortion arising from a manager's performance-based compensation contract is important for understanding the empirical patterns of corporate policies.

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#### Table I: Calibrated Model Parameters

This table presents the calibrated and estimated parameters of the model. Where applicable, the parameter refers to an annual frequency.

| Production parameters          |           |       |  |  |  |  |  |
|--------------------------------|-----------|-------|--|--|--|--|--|
| Description                    | Parameter | Value |  |  |  |  |  |
| Returns to scale               | $\alpha$  | 0.863 |  |  |  |  |  |
| Depreciation rate              | $\delta$  | 0.091 |  |  |  |  |  |
| Productivity shock persistence | $ ho_z$   | 0.737 |  |  |  |  |  |
| Discount factor                | eta       | 0.95  |  |  |  |  |  |
| Capital adjustment cost        | b         | 0.5   |  |  |  |  |  |
| External financing cost        | $\lambda$ | 0.02  |  |  |  |  |  |
| Manager risk aversion          | $\gamma$  | 3     |  |  |  |  |  |
| Corporate tax rate             | $	au_c$   | 0.35  |  |  |  |  |  |
| Personal tax rate              | $	au_d$   | 0.15  |  |  |  |  |  |

Distribution Statistics for Firm-specific Parameters

| Description                   | Parameter       | mean  | median | sd    |
|-------------------------------|-----------------|-------|--------|-------|
| Productivity shock volatility | σ               | 0.197 | 0.174  | 0.135 |
| Fixed pay compensation        | F/k~(%)         | 0.49  | 0.17   | 1.31  |
| Stock compensation            | $	heta_s~(\%)$  | 2.51  | 0.38   | 5.95  |
| Option compensation           | $\theta_o~(\%)$ | 1.23  | 0.83   | 1.47  |

#### Table II: Summary Statistics for Investment Distortion

This table reports the distribution statistics for the overinvestment distortion faced by the manager,  $\omega_{it}$ . All values are in percentage points and correspond to an annual investment rate.

|               | mean | $\operatorname{sd}$ | p1    | p5    | p10   | p25  | p50  | p75  | p90  | p95  | p99  |
|---------------|------|---------------------|-------|-------|-------|------|------|------|------|------|------|
| $\omega_{it}$ | 1.47 | 1.65                | -2.19 | -1.42 | -0.81 | 0.15 | 1.75 | 2.96 | 3.44 | 3.62 | 3.98 |

#### Table III: Overinvestment Incentive by Industry

This table presents summary statistics for estimated values of  $\omega_{it}$ , the manager's overinvestment incentive, by industry. All values are reported in percentage points and refer to an annual investment rate. The industry classification is the Fama-French 17 industry definition, based on firm SIC codes. (Further information is provided at Ken French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data\_library.html). Financials and utilities are excluded from the sample.

|                | mean | median | $\operatorname{sd}$ | p25   | p75  |
|----------------|------|--------|---------------------|-------|------|
| Oil            | 0.42 | 0.58   | 1.40                | -0.69 | 1.47 |
| Steel          | 0.87 | 1.15   | 1.61                | -0.64 | 2.24 |
| Mining         | 1.16 | 1.46   | 1.43                | 0.01  | 2.24 |
| Retail         | 1.27 | 0.64   | 1.48                | 0.23  | 2.77 |
| Textiles       | 1.27 | 1.38   | 1.83                | -0.30 | 3.09 |
| Food           | 1.33 | 1.21   | 1.59                | -0.06 | 2.89 |
| Automobiles    | 1.48 | 1.68   | 1.51                | 0.20  | 2.79 |
| Fabricated     | 1.49 | 2.00   | 1.68                | 0.23  | 2.94 |
| Transportation | 1.50 | 1.88   | 1.57                | 0.23  | 2.92 |
| Machinery      | 1.54 | 2.00   | 1.70                | 0.22  | 2.95 |
| Consumer       | 1.57 | 2.03   | 1.59                | 0.19  | 3.00 |
| Other          | 1.57 | 1.98   | 1.71                | 0.18  | 3.13 |
| Construction   | 1.58 | 1.93   | 1.52                | 0.23  | 2.93 |
| Chemicals      | 1.64 | 2.14   | 1.52                | 0.46  | 2.86 |
| Drugs          | 2.14 | 2.66   | 1.50                | 1.30  | 3.30 |

#### Table IV: Mean and Median Estimated $\omega_{it}$ by Credit Rating

This table reports the mean and median estimated overinvestment incentive,  $\omega_{it}$ , by credit rating. The credit ratings are reported by S&P and taken from the Compustat database. The values for  $\omega_{it}$  are reported in percentage points.

|     | mean  | median |
|-----|-------|--------|
| AAA | 2.48  | 2.96   |
| AA  | 1.84  | 2.44   |
| А   | 1.96  | 2.48   |
| BBB | 1.77  | 2.10   |
| BB  | 1.46  | 1.59   |
| В   | 1.15  | 1.23   |
| CCC | 0.13  | -0.40  |
| CC  | -1.05 | -1.20  |

# Table V: Summary Statistics of Overinvestment Incentive by GIM GovernanceMeasure

This table presents the mean, median, and standard deviation of the estimated overinvestment incentive,  $\omega_{it}$ , sorted into five groups according to the corporate governance measure of Gompers, Ishii, and Metrick (2003). Group 1 corresponds to firms with a low g score (high measured corporate governance) and group 5 are those with a high g score (low measured corporate governance).

|   | mean | median | sd   |
|---|------|--------|------|
| 1 | 1.15 | 1.35   | 1.73 |
| 2 | 1.31 | 1.53   | 1.58 |
| 3 | 1.43 | 1.71   | 1.54 |
| 4 | 1.69 | 2.10   | 1.39 |
| 5 | 1.84 | 2.17   | 1.26 |

#### Table VI: Panel Regressions of $\omega_{it}$ on Firm Characteristics

This table presents regressions of the estimated overinvestment incentive,  $\omega_{it}$ , on firm and manager characteristics. The investment distortion is measured in percentage points, i.e. a coefficient of 1 corresponds to a 1 percentage point change in the investment distortion. Standard errors are clustered at the firm level, and t-statistics are reported in parentheses.

|                   | (1)            | (2)            | (3)           | (4)            | (5)                | (6)           |
|-------------------|----------------|----------------|---------------|----------------|--------------------|---------------|
| VARIABLES         | $\omega_{it}$  | $\omega_{it}$  | $\omega_{it}$ | $\omega_{it}$  | $\omega_{it}$      | $\omega_{it}$ |
|                   |                | الاعلامات و    |               |                |                    |               |
| $\log(Assets)$    | 0.115***       | 0.144***       | 0.131***      | 0.064**        | 0.076**            | 0.229***      |
|                   | (5.38)         | (6.44)         | (3.19)        | (1.99)         | (2.40)             | (3.60)        |
| Asset Tangibility | $-1.176^{***}$ | -0.886***      | -0.819**      | -1.311***      | -0.779***          | -0.608        |
|                   | (-7.63)        | (-4.88)        | (-2.56)       | (-6.08)        | (-3.08)            | (-1.25)       |
| Cash/Assets       | -1.494***      | $-1.161^{***}$ | -0.706***     | $-1.541^{***}$ | $-1.216^{***}$     | 0.124         |
|                   | (-6.75)        | (-5.01)        | (-3.52)       | (-4.46)        | (-3.37)            | (0.38)        |
| Book Leverage     | 0.012          | -0.101         | -0.339*       | -0.083         | -0.144             | 0.056         |
|                   | (0.08)         | (-0.65)        | (-1.88)       | (-0.36)        | (-0.64)            | (0.20)        |
| Profitability     | 0.086***       | 0.112***       | 0.085***      | 0.077**        | 0.105***           | 0.021         |
| -                 | (4.04)         | (5.14)         | (3.80)        | (2.13)         | (2.82)             | (0.53)        |
| Employees/Assets  | 0.498          | 0.268          | -1.497        | -0.326         | 0.982              | 4.198         |
| x 0 /             | (0.29)         | (0.15)         | (-0.65)       | (-0.13)        | (0.38)             | (1.01)        |
| R&D/Sales         | 2.133***       | 1.604***       | -0.341        | 1.654**        | 0.703              | -0.059        |
| 1                 | (4.63)         | (3.06)         | (-0.47)       | (2.51)         | (0.99)             | (-0.07)       |
| SG&A/Sales        | 0.571***       | $0.655^{***}$  | 0.293         | $0.564^{**}$   | 0.647**            | 0.401         |
| 7                 | (2.88)         | (3.15)         | (0.89)        | (2.09)         | (2.43)             | (0.81)        |
| log(CEO Age)      | 0.081          | 0.026          | -0.063        | 0.083          | 0.008              | -0.164        |
|                   | (1.50)         | (0.49)         | (-0.86)       | (1 01)         | (0, 10)            | (-1.46)       |
| log(CEO Tenure)   | -0 573***      | -0.560***      | -0.396***     | -0 576***      | -0 559***          | -0.316***     |
| log(ello lonaro)  | (-19.50)       | (-19.34)       | (-12.33)      | $(-14\ 15)$    | (-13.95)           | (-6.64)       |
| Low g score       | (10.00)        | (10.01)        | (12.00)       | -0 159*        | -0.131             | -0 231**      |
| Low g score       |                |                |               | (-1, 73)       | (-1.44)            | (-2.17)       |
| High g score      |                |                |               | 0.111          | 0.081              | (2.17)        |
| ingli g score     |                |                |               | (1.34)         | (1.00)             | (-0.67)       |
| Constant          | 1 679***       | 1 502***       | 1 691***      | (1.04)         | (1.00)<br>2.170*** | (-0.07)       |
| Constant          | (7.91)         | (6.47)         | (1.68)        | 2.404          | 2.170              | (1.80)        |
|                   | (7.81)         | (0.47)         | (4.08)        | (7.13)         | (0.21)             | (1.80)        |
| Observations      | 16,953         | $16,\!953$     | 16,953        | 6,999          | 6,999              | 6,999         |
| R-squared         | 0.160          | 0.209          | 0.598         | 0.181          | 0.234              | 0.703         |
| Time FE           | No             | Yes            | No            | No             | Yes                | No            |
| Firm FE           | No             | No             | Yes           | No             | No                 | Yes           |
| Industry FE       | No             | Yes            | _             | No             | Yes                | _             |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

|                                | (1)     | (2)          | (3)     | (4)     | (5)          | (6)          |
|--------------------------------|---------|--------------|---------|---------|--------------|--------------|
|                                | Q       | $\mathbf{Q}$ | Q       | Q       | $\mathbf{Q}$ | $\mathbf{Q}$ |
| $\mathbb{1}_{[\omega_{it}>0]}$ | -0.255  | -0.300       | -0.291  | -0.353  | -0.173       | -0.168       |
|                                | (-4.22) | (-5.21)      | (-5.05) | (-6.34) | (-4.59)      | (-4.37)      |
| Log Assets                     | -0.0784 | -0.108       | -0.0738 | -0.104  | -0.492       | -0.492       |
|                                | (-3.45) | (-4.58)      | (-3.45) | (-4.63) | (-13.82)     | (-13.66)     |
| Dividend Payer                 | -0.0600 | -0.167       | 0.0762  | -0.0131 | 0.0394       | 0.0362       |
|                                | (-1.07) | (-2.99)      | (1.39)  | (-0.24) | (0.82)       | (0.74)       |
| R&D/Assets                     | 6.727   | 6.978        | 4.397   | 4.641   | 0.854        | 0.861        |
|                                | (11.41) | (12.04)      | (6.65)  | (7.06)  | (1.32)       | (1.33)       |
| Equity Volatility              |         | -0.440       |         | -0.383  |              | -0.0212      |
|                                |         | (-8.15)      |         | (-7.66) |              | (-0.57)      |
| Total Incentive Pay            |         | 0.213        |         | -0.284  |              | 0.200        |
| · ·                            |         | (0.45)       |         | (-0.62) |              | (0.51)       |
| Observations                   | 16332   | 16326        | 16332   | 16326   | 16332        | 16326        |
| Adjusted $R^2$                 | 0.149   | 0.160        | 0.235   | 0.243   | 0.204        | 0.203        |
| Time Fixed Effects             | Yes     | Yes          | Yes     | Yes     | Yes          | Yes          |
| Industry Fixed Effects         | No      | No           | Yes     | Yes     |              |              |
| Firm Fixed Effects             | No      | No           | No      | No      | Yes          | Yes          |

Table VII: Valuation ratios and binary overinvestment incentives estimate

This table presents regressions of Tobin's Q on an overinvestment incentive dummy variable and controls. The incentive dummy is 1 when  $\omega_{it} > 0$  and 0 otherwise. Controls follow Lang and Stulz (1994) and include log of total assets, R&D expense over total assets, volatility of weekly equity returns, and total incentive pay, measured as the sum of stock and option grants as a fraction of total shares outstanding. Standard

errors are clustered at the firm level, and t-statistics are reported in parentheses.

|                        | (1)          | (2)          | (3)     | (4)     | (5)          | (6)          |
|------------------------|--------------|--------------|---------|---------|--------------|--------------|
|                        | $\mathbf{Q}$ | $\mathbf{Q}$ | Q       | Q       | $\mathbf{Q}$ | $\mathbf{Q}$ |
| $\omega_{it}$          | -5.094       | -6.225       | -6.253  | -7.749  | -5.488       | -5.522       |
|                        | (-3.14)      | (-3.89)      | (-4.03) | (-4.96) | (-4.65)      | (-4.56)      |
| Log Assets             | -0.0861      | -0.114       | -0.0826 | -0.112  | -0.496       | -0.498       |
|                        | (-3.83)      | (-4.81)      | (-3.89) | (-4.97) | (-13.93)     | (-13.81)     |
| Dividend Payer         | -0.0590      | -0.162       | 0.0759  | -0.0104 | 0.0414       | 0.0363       |
|                        | (-1.05)      | (-2.89)      | (1.38)  | (-0.19) | (0.86)       | (0.74)       |
| R&D/Assets             | 6.767        | 7.040        | 4.392   | 4.642   | 0.796        | 0.804        |
| ,                      | (11.37)      | (12.05)      | (6.63)  | (7.07)  | (1.23)       | (1.24)       |
| Equity Volatility      |              | -0.433       |         | -0.375  |              | -0.0282      |
| 1 0 0                  |              | (-7.95)      |         | (-7.49) |              | (-0.77)      |
| Total Incentive Pav    |              | 0.406        |         | -0.112  |              | 0.0541       |
|                        |              | (0.82)       |         | (-0.23) |              | (0.14)       |
| Observations           | 16332        | 16326        | 16332   | 16326   | 16332        | 16326        |
| Adjusted $R^2$         | 0.147        | 0.157        | 0.233   | 0.240   | 0.205        | 0.204        |
| Time Fixed Effects     | Yes          | Yes          | Yes     | Yes     | Yes          | Yes          |
| Industry Fixed Effects | No           | No           | Yes     | Yes     |              |              |
| Firm Fixed Effects     | No           | No           | No      | No      | Yes          | Yes          |

Table VIII: Valuation ratios and continuous overinvestment estimate

This table presents regressions of Tobin's Q on the overinvestment incentive estimate,  $\omega_{it}$ , and controls. Controls follow Lang and Stulz (1994) and include log of total assets, R&D expense over total assets, volatility of weekly equity returns, and total incentive pay, measured as the sum of stock and option grants as a fraction of total shares outstanding. Standard errors are clustered at the firm level, and t-statistics are

reported in parentheses.

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|                         | (1)           | (2)           | (3)     | (4)     | (5)          |
|-------------------------|---------------|---------------|---------|---------|--------------|
|                         | $\omega_{it}$ | $\omega_{it}$ | Q       | Q       | $\mathbf{Q}$ |
| Diversification Dummy   | 0.00241       | 0.00157       | -0.273  |         | -0.271       |
|                         | (4.36)        | (2.52)        | (-5.79) |         | (-5.74)      |
| $\omega_{it}$           |               |               |         | -5.698  | -5.611       |
|                         |               |               |         | (-3.93) | (-3.88)      |
| Log Assets              |               |               | -0.0766 | -0.0834 | -0.0660      |
|                         |               |               | (-3.67) | (-3.93) | (-3.12)      |
| Dividend Payer          |               |               | 0.0857  | 0.0751  | 0.0921       |
|                         |               |               | (1.56)  | (1.37)  | (1.68)       |
| R&D/Assets              |               |               | 3.990   | 4.390   | 4.112        |
|                         |               |               | (6.02)  | (6.63)  | (6.30)       |
| Constant                | 0.0133        | 0.0132        | 1.201   | 1.326   | 1.213        |
|                         | (29.59)       | (9.50)        | (5.39)  | (5.35)  | (5.40)       |
| Observations            | 18595         | 16332         | 16332   | 16332   | 16332        |
| Adjusted $\mathbb{R}^2$ | 0.005         | 0.070         | 0.236   | 0.233   | 0.240        |
| Year Fixed Effects      | No            | Yes           | Yes     | Yes     | Yes          |
| Industry Fixed Effects  | No            | Yes           | Yes     | Yes     | Yes          |

Table IX: Valuation ratios on diversification and incentive variable

This table presents regressions of the overinvestment incentive estimate,  $\omega_{it}$ , on a diversification dummy in Columns (1) and (2), and Tobin's Q on the overinvestment incentive estimate,  $\omega_{it}$ , on a diversification dummy and controls in Columns (3)–(5). The diversification dummy is set to 1 for firms with more than one industry segments which comprise at least 10% of sales, and 0 otherwise, as defined in Lang and Stulz (1994). Controls include log of total assets, and R&D expense over total assets. Standard errors are clustered at the

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#### Table X: Change in investment and incentives

This table presents regressions of changes in investment rates,  $\Delta \frac{I_t}{K_{t-1}} \equiv \frac{I_t}{K_{t-1}} - \frac{I_{t-1}}{K_{t-2}}$ , on changes and levels of of the overinvestment incentive estimate,  $\omega_{it}$ , and other controls. Controls includes Tobin's Q, cashflow to PP&E, log of weekly equity return volatility, stock returns  $(R_{t-1})$ , and log of PP&E  $(\log(K_{t-1}))$ . To reduce the impact of outliers due to estimation error, observations are dropped when  $\Delta \omega_{it}$  is above or below the 97.5 and 2.5 percentiles. Standard errors are clustered at the firm level, and t-statistics are reported in parentheses.

|                                 | (1)                    | (2)                    | (3)                    | (4)                    | (5)                    | (6)                    |
|---------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
|                                 | $\Delta I_t / K_{t-1}$ |
| $\Delta \omega_{i,t-1}$         | 0.879                  | ·                      | 1.114                  |                        | 0.518                  |                        |
| ,                               | (2.96)                 |                        | (3.63)                 |                        | (1.73)                 |                        |
| $\omega_{i,t-1}$                |                        | 0.658                  |                        | 1.007                  |                        | 0.456                  |
| ,                               |                        | (5.37)                 |                        | (5.21)                 |                        | (2.66)                 |
| $\Delta Q_{t-1}$                | 0.0696                 | 0.0696                 | 0.0679                 | 0.0680                 | 0.0248                 | 0.0244                 |
|                                 | (10.49)                | (10.53)                | (10.10)                | (10.16)                | (3.55)                 | (3.49)                 |
| $\Delta CF_{t-1}/K_{t-2}$       | 0.00455                | 0.00451                | 0.00271                | 0.00280                | 0.00464                | 0.00474                |
| ,                               | (0.50)                 | (0.49)                 | (0.28)                 | (0.30)                 | (0.55)                 | (0.56)                 |
| $\Delta \text{Log Vol}_{t-1}$   | × ,                    | ~ /                    | · · · ·                | · · · ·                | 0.0332                 | 0.0294                 |
|                                 |                        |                        |                        |                        | (3.78)                 | (3.39)                 |
| $\Delta R_{t-1}$                |                        |                        |                        |                        | -0.00964               | -0.00973               |
|                                 |                        |                        |                        |                        | (-1.40)                | (-1.41)                |
| $\Delta \text{Log K}_{t-1}$     |                        |                        |                        |                        | -0.376                 | -0.376                 |
|                                 |                        |                        |                        |                        | (-14.73)               | (-14.74)               |
| $Q_{t-1}$                       |                        |                        |                        |                        | 0.00621                | 0.00698                |
| •                               |                        |                        |                        |                        | (1.47)                 | (1.65)                 |
| $CF_{t-1}/K_{t-2}$              |                        |                        |                        |                        | 0.00390                | 0.00363                |
|                                 |                        |                        |                        |                        | (0.60)                 | (0.56)                 |
| $\log \operatorname{Vol}_{t-1}$ |                        |                        |                        |                        | -0.0565                | -0.0527                |
|                                 |                        |                        |                        |                        | (-7.00)                | (-6.51)                |
| $R_{t-1}$                       |                        |                        |                        |                        | 0.0657                 | 0.0661                 |
|                                 |                        |                        |                        |                        | (4.92)                 | (4.93)                 |
| $\log K_{t-1}$                  |                        |                        |                        |                        | -0.0608                | -0.0602                |
|                                 |                        |                        |                        |                        | (-9.88)                | (-9.79)                |
| Constant                        | -0.00945               | -0.0187                | -0.00956               | -0.0238                | -0.209                 | -0.202                 |
|                                 | (-7.84)                | (-7.62)                | (-24.54)               | (-8.78)                | (-6.32)                | (-6.13)                |
| Observations                    | 14257                  | 14257                  | 14257                  | 14257                  | 13053                  | 13053                  |
| Adjusted $R^2$                  | 0.041                  | 0.042                  | 0.040                  | 0.041                  | 0.237                  | 0.237                  |
| Year Fixed Effects              | No                     | No                     | No                     | No                     | Yes                    | Yes                    |
| Firm Fixed Effects              | No                     | No                     | Yes                    | Yes                    | Yes                    | Yes                    |

#### Table XI: Predicting acquisition activity

This table presents a logit regression where the dependent variable is an indicator that is set to 1 when the firm announces an acquisition in the next year. The industry wave is a binary variable set to 1 when the industry is currently undergoing a merger wave, and is constructed following Harford (2005). Other controls include Tobin's Q, cashflow to PP&E, log of market value of equity  $(\log(ME))$ , and equity returns (R). All independent variables are lagged one year relative to the acquisition announcement indicated in the dependent variable. Standard errors are clustered at the firm level, and t-statistics are reported in parentheses.

|                        | (1)                | (2)                | (3)  | (4)  | (5)  | (6)  |
|------------------------|--------------------|--------------------|--|--|--|--|
|                        | Acquire            | Acquire            | Acquire  | Acquire  | Acquire  | Acquire  |
| $\omega_{it}$          | 14.04<br>(4.19)    |                    | 12.17<br>(3.66)                                  |  | 9.349<br>(2.90)                                  |  |
| $\Delta \omega_{it}$   |                    | 11.60<br>(2.69)    |  | 14.40<br>(2.49)                                  |  | 12.16<br>(1.86)                                |
| Industry Wave          |                    |                    | $0.527 \\ (4.17)$                                | $\begin{array}{c} 0.533 \\ (4.23) \end{array}$   | $\begin{array}{c} 0.339 \\ (2.25) \end{array}$   | $\begin{array}{c} 0.337 \\ (2.25) \end{array}$ |
| Q                      |                    |                    | $\begin{array}{c} 0.0139 \\ (0.36) \end{array}$  | $\begin{array}{c} 0.00356 \\ (0.09) \end{array}$ | -0.161<br>(-3.55)                                | -0.180<br>(-4.04)                              |
| CF/K                   |                    |                    | $\begin{array}{c} 0.00537 \\ (0.16) \end{array}$ | $\begin{array}{c} 0.0126 \\ (0.39) \end{array}$  | $\begin{array}{c} 0.00177 \\ (0.05) \end{array}$ | 0.00819<br>(0.24)                              |
| Log ME                 |                    |                    | $0.534 \\ (15.65)$                               | $0.546 \\ (16.01)$                               | 0.624<br>(16.62)                                 | $0.636 \\ (16.93)$                             |
| R                      |                    |                    | $\begin{array}{c} 0.201 \\ (2.35) \end{array}$   | $0.164 \\ (1.96)$                                | $0.135 \\ (1.44)$                                | $\begin{array}{c} 0.120 \\ (1.30) \end{array}$ |
| Constant               | -3.211<br>(-40.32) | -2.981<br>(-52.85) | -7.821<br>(-25.84)                               | -7.667<br>(-25.75)                               | -9.398<br>(-8.33)                                | -9.259<br>(-8.28)                              |
| Observations           | 15893              | 15893              | 13492  | 13492  | 13340  | 13340  |
| Pseudo $\mathbb{R}^2$  | 0.006              | 0.001              | 0.098  | 0.095  | 0.154  | 0.153  |
| Year Fixed Effects     | No                 | No                 | No   | No   | Yes  | Yes  |
| Industry Fixed Effects | No                 | No                 | No   | No   | Yes  | Yes  |



Figure 1: Distribution for Estimated Overinvestment Incentive. The figure plots the distribution of the estimated overinvestment incentive,  $\omega_{it}$ . This represents the manager's incentive to overinvest (underinvest for negative values) relative to the optimal investment policy that would be chosen by a diversified shareholder. The estimation is done for each firm and year in the sample. Details on the construction and estimation of  $\omega_{it}$  can be found in Section 3.



Figure 2: Time Series of the Cross-Sectional Average  $\omega_{it}$ . The figure plots the time series of the cross-sectional average of the manager's estimated overinvestment incentive,  $\omega_{it}$ . The units refer to an annual investment rate. For example, 0.014 corresponds to a manager having incentive to overinvest by 1.4 percentage points.



Figure 3: **Persistence in**  $\omega_{it}$ . This figure plots average  $\omega_{it}$  in event time for firms sorted into quartiles based on  $\omega_{it}$  at event year 0. The construction is as follows. Each calendar year, firms are sorted into quartiles based on  $\omega_{it}$ . These bin assignments are retained for the subsequent ten years and the average  $\omega_{it}$  for each bin is calculated in each of these event years 0-10. This is repeated for every calendar year 1992-2002, which generates 11 averages for each quartile. Within each quartile, the 11 averages are averaged, and this quartile average is plotted in event time. Dashed lines show the 95% confidence intervals for each quartile. Firms do no switch bins once assigned, however, firms may drop out of the sample before event year 10.



Figure 4: **Persistence in**  $\omega_{it}$ , **Survivors Only**. This figure plots average  $\omega_{it}$  in event time for firms sorted into quartiles based on  $\omega_{it}$  at event year 0. The construction is the same as in Figure 3. In contrast, however, firms are only included if they do not drop out of the sample before event year 10. This approach controls for potential survivorship bias.



Figure 5: Scatter Plot of  $\omega_{it}$  and Firm Volatility. The figure shows a scatter plot of a firm's estimated overinvestment incentive,  $\omega_{it}$ , on its volatility. Each point represents a firm-year observation.



Figure 6: Scatter Plot of  $\omega_{it}$  and Stock Compensation. The figure shows a scatter plot of a firm's estimated overinvestment incentive,  $\omega_{it}$ , on its CEO stock compensation. The stock compensation is measured as the number of shares held by the CEO as a fraction of the firm's total shares outstanding. Each point represents a firm-year observation.



Figure 7: Scatter Plot of  $\omega_{it}$  and Option Compensation. The figure shows a scatter plot of a firm's estimated overinvestment incentive,  $\omega_{it}$ , on its CEO option compensation. The options compensation is measured as the number of shares in options held by the CEO as a fraction of the firm's total shares outstanding. Each point represents a firm-year observation.



Figure 8: Distribution of the Ratio of Manager to Shareholder Run Capital Stock in the Steady State. The figure plots the distribution of the ratio of the steady-state capital stock under the manager-run firm to the steady-state capital stock under a firm run by a shareholder with no overinvestment incentive.



Figure 9: Distribution of the Ratio of Manager to Shareholder Run Firm Value in the Steady State. The figure plots the distribution of the ratio of the steady-state firm value under the manager-run firm to the steady-state firm value under a firm run by a shareholder with no overinvestment incentive.



Figure 10: Median Book Leverage by  $\omega_{it}$  Decile. We sort firm-year observations into deciles based on their estimated overinvestment incentive,  $\omega_{it}$ . The figure plots the median book leverage by  $\omega_{it}$  decile.



Figure 11: Median Cash/Assets by  $\omega_{it}$  Decile. We sort firm-year observations into deciles based on their estimated overinvestment incentive,  $\omega_{it}$ . The figure plots the median cash/asset ratio by  $\omega_{it}$  decile.