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# Why Do Managers Diversify Their Firms? Agency Reconsidered

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**ABSTRACT**

We develop a contracting model between shareholders and managers in which managers diversify their firms for two reasons: to reduce idiosyncratic risk and to capture private benefits. We test the comparative static predictions of our model. In contrast to previous work, we find that diversification is positively related to managerial incentives. Further, the link between firm performance and managerial incentives is weaker for firms that experience changes in diversification than it is for firms that do not. Our findings suggest that managers diversify their firms in response to changes in private benefits rather than to reduce their exposure to risk.

WHY DO MANAGERS CHOOSE to diversify their firms? A sizable literature suggests that corporate diversification is a leading example of the agency relationship between shareholders and managers developed by Jensen and Meckling (1976). Agency theory argues that, because managers are not full residual claimants, they make decisions that increase their utility while potentially decreasing the value of the firm. There are two prominent types of agency explanations for why managers choose to diversify their firms.

The first type of agency explanation is that managers derive utility from reducing the idiosyncratic risk that they face. Managers typically have large, undiversified positions in their own firms.[1] Managers with higher equity ownership face higher idiosyncratic risk from incentives and therefore diversify their firms more to lower that risk. May (1995) finds that CEOs with more wealth tied up in firm equity engage in acquisitions that are more diversifying. He interprets the

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[1] Jin (2002) argues that inadequate portfolio diversification is the real cost to managers of providing managerial incentives.

positive relationship between diversification and managerial equity ownership as support for the risk reduction explanation.[2]

The second type of agency explanation is that managers diversify because they derive a private benefit, as in Jensen (1986) and Stulz (1990), from managing a more diversified firm. These private benefits may come from a variety of sources. They may arise from prestige or better career prospects associated with running a more diversified firm. Private benefits may arise because running a more diversified firm increases managers' pay or their opportunities for skimming or because it entrenches them, making them more valuable to the firm. In contrast to May's (1995) results, Denis, Denis, and Sarin (1997) find evidence of less diversification in firms with higher managerial equity ownership. They interpret this as evidence that higher equity ownership offsets the private benefits managers derive from diversifying.[3]

Both of the agency explanations as stated are incomplete and somewhat misleading. The risk reduction explanation treats the level of incentives (managerial ownership) as exogenously determined. Once incentives are set, managers then choose the level of diversification to reduce their exposure to idiosyncratic risk. However, if managers are averse to idiosyncratic risk, then why do owners give managers any incentives at all? Because the positive effects of incentives do not explicitly enter the risk reduction explanation, this explanation does not fully depict an equilibrium of a model in which diversification results from agency behavior.

The private benefits explanation also treats the level of managerial incentives as exogenously determined. However, owners of firms can choose the level of incentives to influence managers' actions. If managers diversify because of private benefits and incentives reduce diversification, why do owners not increase incentives until managers choose not to diversify at all? Clearly, there must be costs associated with providing incentives as well. But because these costs do not explicitly enter the private benefits explanation, this explanation also does not fully depict an equilibrium of a model in which diversification results from agency behavior.

We argue that incentives are set in equilibrium as a result of optimal contracting. We present a model that incorporates both types of agency explanation. Managers benefit from reducing their exposure to idiosyncratic risk. Managers also derive a general private benefit from diversifying. Our model further incorporates a positive but costly action (such as an effort choice from a standard principal–agent model) that managers can take to improve firm performance.

The key to our model is that we treat the manager's incentives as endogenous. We focus on incentives provided by tying managers' compensation to the performance of their firms.[4] We also allow the contract to be written on the level of

[2] Amihud and Lev (1981) also suggest that risk reduction might be a motive for diversification. For a general discussion of the relationship between risk reduction and agency in diversification, see Hermalin and Katz (2000).

[3] Anderson et al. (2000) also find evidence of less equity ownership and lower incentives in more diversified firms. They conclude, however, that this is not attributable to agency problems.

[4] We use the terms firm value and firm performance interchangeably.

diversification chosen by the manager.[5] The optimal contract depends on four exogenous parameters: the manager's risk aversion, the variance of shocks to firm performance, the disutility associated with taking value-enhancing actions, and the magnitude of the private benefits associated with diversification. Shifts in these exogenous parameters dictate the comparative statics that will be observed in equilibrium.

For example, when there is an exogenous increase in the manager's private benefits from a given level of diversification, in equilibrium, the manager receives more incentives from the shareholders and diversifies more. Empirically, we would observe higher diversification associated with higher incentives. As another example, when there is an exogenous increase in the risk the manager faces, in equilibrium, the manager receives fewer incentives from the shareholders and diversifies more. Empirically, we would observe higher diversification associated with lower incentives. Understanding the equilibrium comparative statics is critical to understanding the nature of the agency problem.

We test our model using data on managerial incentives from Standard and Poor's ExecuComp data set. Our sample consists of comprehensive data for the top five executives (ranked annually by salary and bonus) from the S&P 500, S&P MidCap 400, and S&P SmallCap 600 companies from 1993 to 1998. We use firm performance and diversification data from COMPUSTAT. Our data set allows us to carefully isolate the relationship between firm performance, diversification, and incentives.

We find that firm performance is increasing in incentives and decreasing in diversification, consistent with the previous literature.[6] More importantly, we find evidence that diversification is increasing in incentives, in contrast to Denis et al. (1997) and Anderson et al. (2000). We show that the negative relationship found in those studies is the result of unobserved, firm-specific factors. We control for these factors by using firm-level fixed effects. The result that diversification is increasing in incentives suggests that changes in incentives and diversification are due to changes in the private benefits associated with diversification. While this empirical finding is consistent with May's (1995) results, as we show in Section IV, this finding cannot be explained in equilibrium by the risk reduction motive on which his analysis is based.

We also test our model by considering how firm performance responds to incentives in firms that experience changes in diversification relative to firms that do not. We find that the link between performance and incentives is significantly

[5] In the Appendix, we show that our theoretical predictions can also be obtained in a model in which diversification is not contractible.

[6] Both agency explanations are consistent with a negative effect of diversification on firm performance. A number of papers, such as Lang and Stulz (1994), Berger and Ofek (1995), Comment and Jarrell (1995), and Servaes (1996), show that firm value (often measured by Tobin's $Q$) is decreasing in diversification. John and Ofek (1995) find that firms that increase their focus or decrease diversification show improved firm performance.

weaker for firms that experience changes in diversification than it is for firms that do not experience changes in diversification. These findings also suggest that observed changes in firm performance, diversification, and incentives within firms are equilibrium responses to shifts in the private benefits managers derive from diversification. Taken together, our results provide robust support for the private benefits explanation of diversification, but on very different grounds than in the existing literature. Our empirical results do not point to risk reduction as the explanation for observed differences in diversification.

Our goal in this paper is to provide a more coherent and comprehensive theory of corporate diversification decisions based on agency considerations. Our theory does not preclude other factors that may affect diversification. For example, diversification may be optimal for some firms for reasons of internal capital markets, as in Stein (1997) and Khanna and Tice (2001). At the same time, diversification may not be optimal, because it is the outgrowth of competition between divisions for scarce corporate resources, as in Rajan, Servaes, and Zingales (2000). For a thorough review and critique of this literature, see Campa and Kedia (2002), Chevalier (2000), Graham, Lemmon, and Wolf (2002), and Maksimovic and Phillips (2002).

The remainder of the paper is organized as follows. In Section I, we present our agency model of diversification and derive the equilibrium comparative static predictions we will test. In Section II, we describe our data on incentives, firm performance, and diversification. We present the econometric results in Section III. Section IV discusses the robustness of our findings and their relation to those in the existing literature. Section V concludes.

## I. Theory

In this section, we present a principal–agent model in which we incorporate the possibility that the agent enjoys both risk reduction and private benefits from diversification. We derive the equilibrium relationships between firm value, diversification, and incentives. In Section I.A, we discuss the nature of the private benefits that we model. In Section I.B, we present the model. In Section I.C, we discuss how the model can be tested empirically.

### *A. Private Benefits*

In our model, managers derive two types of benefits from diversifying their firms—reducing idiosyncratic risk and more general private benefits. The private benefits may come from a variety of sources that have been suggested in the literature, and these private benefits may change over time. Here we discuss in greater detail the types of private benefits we have in mind.

One type of private benefit is that a manager may wish to run a more diversified firm because it improves her future career prospects (Gibbons and Murphy (1992)). Experience in running a more complex organization increases the labor market's perception of the manager's ability.[7] Perceived ability is especially important for managers who wish to move to bigger or more visible firms. As an example, consider the announcement of a successor at Graco, Inc. The outgoing CEO and Graco's Chairman George Aristides said in *Business Wire* (2001):

> The Board selected [David A. Roberts] because he has a diversified background and a proven track record of success in several business environments. He brings experience in many areas including manufacturing, distribution and international operations.

The value to the manager of having high perceived ability can change through time. For example, a manager who has been recently promoted or moved to another firm may not be concerned about perceived ability, while one who has not moved or been promoted may be very concerned. A manager who becomes more concerned with perceived ability has a greater private benefit of diversification.

Similarly, a manager may derive additional nonpecuniary private benefits through the prestige, power, and perquisites of running a more diversified firm (Jensen (1986) and Stulz (1990)). It can also be quite valuable in terms of social status for a manager to say that she runs a more complex organization. Social status depends on how widely the manager is known across different lines of business. Increases in the perceived power, prestige, or perquisites associated with running a diversified firm will induce managers to want to diversify more. The extent to which managers care about their social status may change over time. Social status may follow fads, inducing managers to add lines of business in socially prominent industries—for example, Internet-related businesses in the 1990s. Another possibility is that managers suffer from hubris (Roll (1986)). Over time, managers may come to believe more in their capabilities, whether justified or not. As a result, they become more inclined to increase their social status by diversifying the firm.

Other sources of the general private benefit of diversification include classic rent seeking and managerial entrenchment. Managers may wish to run a more diversified firm to increase their pay (Jensen and Murphy (1990)) or their opportunities for skimming (Bertrand and Mullainathan (2001)). Running a more complex firm may allow managers to siphon off more firm resources. If the resources that can be siphoned off increase, managers' private benefits increase, as diversifying allows them to take greater advantage of the opportunity. Similarly, if the technology with which managers siphon off resources improves, the value of diversifying will increase for the manager. Conversely, if the technology to prevent this type of skimming improves, the value of diversifying will decrease and the firm will become more focused.

A related source of this private benefit is entrenchment. Diversifying the firm may entrench managers, making it more costly for the firm to replace them (Shleifer and Vishny (1989)). As a result, when managers feel their positions have become less secure, they will diversify more to entrench themselves. They may feel less secure because other managers have become viable replacements, or because

[7] Rose and Shepard (1997) find that CEOs who run more diversified firms are paid more and argue that this is because higher ability CEOs are matched to more complex organizations.

shareholders or the board feel the managers' performance is weak. All of these are potentially sources of the private benefits that we model. Several examples will illustrate these ideas.

*Example 1: Viacom's Acquisition of Blockbuster*

In announcing this acquisition in 1994, Sumner Redstone, Chairman of Viacom, said in Viacom (1994):

> With the completion of Viacom's merger with Blockbuster, we have created a single, incomparable, global media colossus. The new Viacom not only controls many of the world's most valuable and recognizable entertainment and publishing brands, but also has the distribution, size and scope to drive these brands into every region of the world. With pro forma combined capitalization of $26 billion at June 30, 1994, Viacom is positioned to become the fastest growing media company in the world.

The creation of the "global media colossus" was not cheap:

> Viacom paid $8.4 billion for Blockbuster in 1994. Now, says Merrill Lynch & Co. media analyst Jessica Reif-Cohen, it's worth just $4.6 billion, because of its slipping cash flow. "That's an incredible loss of value in only three years." (Lesly (1997))

The 1999 IPO of Blockbuster also valued it at $4.6 billion. In subsequent trading, the value slipped to $1.5 billion before recovering to close to the IPO value. In Redstone's case, the acquisition of Blockbuster was part of a pattern of diversification through acquisition that had begun in the 1980s.[8]

*Example 2: LTV Corporation's Diversification Strategy in the 1990's*

The LTV Corporation's Annual Report for 1999 states that:

> As part of LTV's strategy of pursuing growth in metal fabrication businesses, the Company acquired Welded Tube Co. of America on October 1, 1999 and Copperweld Corporation and Copperweld Canada Inc. on November 10, 1999. The aggregate purchase price paid in 1999 was $764 million. These tubular product companies were combined with LTV's existing tubular products business to create LTV Copperweld, which is now the largest and most diverse manufacturer of tubular products in North America.

*Business Week* (Arndt (2000)) noted that:

> Laudably, the men who run LTV have made investments outside traditional steelmaking in search of higher returns. In autumn 1999, [LTV Chairman

[8] In 1994, Viacom also acquired Paramount. For a detailed discussion of Viacom's overpayment for Paramount and how this reflects Redstone's private benefits of diversification, see Hietala, Kaplan, and Robinson (2000).

> and CEO J. Peter] Kelly overrode the objections of several institutional shareholders and spent $764 million in stock and borrowed cash on two steel-tube fabricators. Including these, however, the tube plants are a drain on earnings. And they didn't come cheap. Debt-free seven years ago, LTV now owes more than $1 billion in long-term debt, with the notes on its tube deals carrying a burdensome interest rate of 11.75% for 10 years.

On December 29, 2000, the LTV Corporation and its wholly owned subsidiaries (including LTV Copperweld) filed for Chapter 11 bankruptcy. LTV had previously filed for bankruptcy in 1986 and emerged in 1993. "What management has done to destroy shareholder value defies belief," says Frank Dunau, a portfolio manager for Harvard University (Arndt (2000)). A former board member at LTV argues that senior management decided it did not wish to run an old steel company with limited growth prospects, and instead sought diversification opportunities.[9]

*Example 3: Mattel's Acquisition of the Learning Company and Subsequent Refocusing Attempts*

In December of 1998, Mattel announced it was acquiring the Learning Company. In her letter to shareholders in the 1998 Annual Report, Jill Barad, CEO and chairman of the board, said:

> It made great sense for us to seek out a partner to help us realize our $1 billion [sales] goal. The only company that met all the criteria we established was The Learning Company. We announced our proposed merger with The Learning Company in December. This merger will provide Mattel with tremendous opportunities for synergies, cross branding, age expansion, consumer relevancy and channel expansion. The Learning Company holds the #1 market share for both education software and productivity software, the #2 position for reference, and the #3 ranking for entertainment. After the merger's completion, we will become the second largest consumer software company in the world, second only to Microsoft.

That this merger was based on a goal of sales maximization was confirmed by Glenn Bozarth, senior vice president of corporate communications at Mattel:

> We've been successful in developing our own capability in interactive, but at Mattel we knew we wanted to build this to be a large business and we never could have built it so quickly without this merger. We had a goal that we wanted to do $1 billion in interactive last year. We were at about $100 million. The merger, upon completion, will allow us to meet that goal. (Symons (1999))

[9] Private communication.

Barad's motives were clear: "To catapult Mattel out of the stagnant toy business—kids seem to outgrow their playthings at ever younger ages—Barad had pinned her hopes on leveraging the company's Barbie, Matchbox, and other brands into software, videogames, and Internet products" (Sherrid (2000)).

The merger turned out to be disastrous.

> Mattel Inc., the toymaker that is virtually synonymous with the best-selling doll, saw an opportunity to diversify into non-toy products two years ago. It was riding high with solid earnings and a strong stock price, and went after the Learning Co., an educational software firm that it soon acquired for $3.5 billion. But it was Mattel that learned a hard lesson. The merger was ill-conceived—Mattel didn't know the software business—and within a matter of months the Learning Co. was put on the block, selling last year for no cash upfront. Mattel's earnings took a drubbing, with per share earnings falling from $1.11 in 1998 to a 29-cent loss in 1999 and a loss of $1.01 last year. With that, Mattel's stock plummeted as well, falling sharply in 1999–2000 and starting this year off a full 60 percent from two years earlier. The Learning Co. deal ended up as the last straw for Mattel's board, which fired beleaguered Mattel chief executive Jill Barad last year. (Marshall (2001))

Several sources argued that the Board delayed action in firing Barad for some time. *Business Week* described the Board of Directors as "a deeply entrenched group of directors that two years ago rubber-stamped a $3.5 billion acquisition of The Learning Co., which saddled the company with roughly $300 million in losses" (Grover (2000)).

Robert A. Eckert, the president of Kraft Foods, Inc., was hired to replace Barad. In his letter to shareholders in the 2000 Annual Report, Eckert, now CEO and chairman of the board of Mattel, said:

> "Refocus" is the one word we chose to use on the cover of this annual report, because in one word it describes our mission going forward. Our new vision refocuses Mattel on its core business toys; its core competency building brands; its opportunity for global growth, and its leadership position with children and their parents. Consistent with our strategy of returning to our roots, we sold The Learning Company in October to Gores Technology Group. The Learning Company was not a good fit with Mattel, and it quickly became clear that we did not need to own a software company in order to capitalize on the growth potential of the interactive games category.

Analysts describe the difference between Eckert and Barad as follows:

> Eckert is the anti-Barad. Where she was known for a hot temper, Eckert is low-key and taciturn. Barad looked to splashy acquisitions and new businesses. Eckert values proven properties, seeking only modest new ventures… One of Eckert's first moves at Mattel was to clean up the Learning Co. fiasco…. He sold the management headache to Los Angeles investor Alec

Gores for no cash—only a 50% share of future profits—and took a $441 million charge. (Palmeri (2001))

It seems clear that Eckert's private benefits from diversifying are lower than Barad's, and as a result, he refocused the firm. Of course, this appears to be exactly what the Board and the shareholders were looking for in choosing the new CEO.

These examples illustrate three primary ways that private benefits can change. First, the individual manager's preference for diversification may directly change. At LTV, CEO J. Peter Kelly decided that he did not want to run a firm in a declining industry like steelmaking. As a result, LTV diversified at the shareholders' expense. Second, a new opportunity for exploiting an existing preference may emerge. This was the issue with Viacom's acquisition of Blockbuster, part of a complicated three-way merger between Paramount, Viacom, and Blockbuster. Such opportunities may also have motivated many of the technology-related acquisitions in the late 1990s, including Mattel's ill-fated purchase of the Learning Company. Third, replacement of existing managers may lead to a change in the preference for diversification at the firm level. When Robert A. Eckert replaced Jill Barad as CEO of Mattel, his preference for corporate focus was directly evident on the cover of the 2000 annual report and indicated a substantially lower private benefit of diversification.

### *B. Model*

To model the risk reduction and private benefits of diversification, we consider a multitask principal–agent setting similar to that in Holmstrom and Milgrom (1987, 1991). Managers (the agent) choose an action $x$ (such as the amount of effort to exert or the level of investment), as well as the amount of diversification $n$. The amount of diversification can be thought of as the number of divisions or the lines of business within the firm, where $n \geq 1$. We assume that firm value is:

$$\pi = x - n + \varepsilon(n), \tag{1}$$

where $\varepsilon(n)$ is a normally distributed shock to firm value with zero mean and variance $\sigma^2/n$. The agent's action choice $x$ is noncontractible. While shareholders (the principal) could potentially monitor managers' action choices, doing so is costly. Doing so is particularly costly in large, publicly traded corporations in which ownership is dispersed.

The agent receives a contract that is linear in firm performance and diversification:[10]

$$w = w_0 + \alpha\pi + \gamma n. \tag{2}$$

The agent receives a fixed wage component (salary) of $w_0$, a performance-based component of $\alpha\pi$, and a component based on diversification $\gamma n$. In this setting, the agent's pay–performance sensitivity is $\alpha$. We can also interpret the previous equa-

[10] We have also derived versions of the model in which contracts can depend only on firm performance and not the diversification choice. We obtain similar comparative statics to those reported here. See Appendix B for a complete description of those results.

tion as a statement about the agent's wealth. If we assume, as is true of most executives, that a large fraction of their wealth is invested in their own firms, then $w_0$ is the component of wealth that is independent of the firm and $\alpha\pi$ is the component of wealth that is attributable to the firm. In this case, $\alpha$ represents executive ownership in the firm.[11]

The agent has negative exponential utility with a coefficient of absolute risk aversion of $r$ and has a certainty equivalent of

$$u = w_0 + \alpha(x - n) + \gamma n - \frac{k}{2}x^2 + z \ln n - \frac{r}{2}\alpha^2 \frac{\sigma^2}{n} \tag{3}$$

The linear certainty equivalent results from the assumptions that the agent has CARA utility and the shock to firm value is normally distributed. The first term after $w_0$ reflects the agent's share of expected firm value. The second term reflects the effect of diversification on the agent's compensation contract. The agent has disutility of the action choice given by $(k/2)x^2$, where we assume $k \geq 1$.

The term $(r/2)\alpha^2(\sigma^2/n)$ represents the cost of the agent's risk aversion or the premium the agent has to be paid to bear risk. As the variance of firm performance depends on diversification, the agent derives a benefit due to risk reduction from diversification, as suggested by Amihud and Lev (1981) and May (1995). If the firm is undiversified ($n = 1$), the variance of firm performance is simply $\sigma^2$. We refer to $\sigma^2$ as idiosyncratic variance. We assume that $r > 0$ and $\sigma^2 > 0$. We also assume that $\frac{1}{k} \geq r\sigma^2$. This assumption bounds how large the agent's disutility of the action choice can be. Without an upper bound on the disutility of the action choice, it is possible that, in equilibrium, incentives would be so low that the manager would gain little from risk reduction through increased diversification. Bounding the disutility of the action choice ensures that our model incorporates the risk reduction motive for diversification.[12]

The agent also derives private benefits from diversification of the form $z \ln n$, where $z \geq 1$.[13] The parameter $z$ indexes the benefits the agent derives from diversification. This functional form captures the idea that there is diminishing marginal utility for the agent from diversification. The agent chooses the level of diversification and her action by maximizing the certainty equivalent (3). The principal maximizes expected firm value net of compensation for the agent, given that the agent will choose the action and the level of diversification to maximize her utility. The timing of the model is:

0: Principal offers agent a contract based on performance $\pi$ and the level of diversification $n$.

[11] We defer a discussion of the interpretation of $\gamma$ until after we derive what $\gamma$ equals in equilibrium.

[12] If $k$ is high enough, then incentives are quite low and the manager is exposed to very little risk. In this case, risk reduction ceases being a motive for diversification. This situation is modeled more starkly in case 4 in Appendix B. We bound $k$ from above to make certain that we are analyzing a case in which both motives (private benefits and risk reduction) are operative.

[13] Assuming $z \geq 1$ guarantees that $n \geq 1$, that is, the firm is at least a single-segment firm.

1. Agent chooses $n$ and an action $x$.
2. $\pi$ is realized and the agent is compensated on $\pi$ and $n$.

Given the principal's choice of incentives, $\alpha$ and $\gamma$, the agent's problem is:

$$\max_{x,n} \quad w_0 + \alpha(x - n) + \gamma n - \frac{k}{2}x^2 + z \ln n - \frac{r}{2}\alpha^2 \frac{\sigma^2}{n}. \tag{4}$$

Note that the agent also has a participation constraint of the form:

$$w_0 + \alpha(x - n) + \gamma n - \frac{k}{2}x^2 + z \ln n - \frac{r}{2}\alpha^2 \frac{\sigma^2}{n} \geq u_0,$$

where $u_0$ is the agent's reservation utility. The first order condition for diversification $n$ gives us[14]

$$n* = \frac{z + \psi}{2(\alpha - \gamma)}, \tag{5}$$

where $\psi = \sqrt{(z^2 + 2r\sigma^2\alpha^3 - 2r\sigma^2\alpha^2\gamma)}$. For the agent's action choice, the first order condition gives us $x*$ as a function of $\alpha$:

$$x* = \frac{\alpha}{k}. \tag{6}$$

Expected firm value net of compensation for the agent is:

$$E[\pi] - w = x* - n* - \frac{k}{2}(x*)^2 + z \ln n* - \frac{r}{2}\alpha^2 \frac{\sigma^2}{n*}. \tag{7}$$

Here we assume that the managerial labor market is competitive, so the agent will be held to her reservation utility, which we normalize to zero ($u_0 = 0$) without loss of generality. Substituting the agent's choice of action and diversification into equation (7) and maximizing with respect to $\alpha$ and $\gamma$ yields the principal's problem:

$$\max_{\alpha,\gamma} \quad \frac{\alpha}{k} - \frac{z + \psi}{2(\alpha - \gamma)} - \frac{\alpha^2}{2k} + z \ln\left(\frac{z + \psi}{2(\alpha - \gamma)}\right) - r\alpha^2 \frac{\sigma^2(\alpha - \gamma)}{z + \psi}. \tag{8}$$

Proposition 1 characterizes the optimal contracts.

PROPOSITION 1: There exists a unique $\alpha* \in (0,1)$ and $\gamma* = \alpha* - 1 < 0$.

*Proof*: See Appendix A.

As we expect, $\alpha* > 0$ and $\gamma* < 0$. The agent's incentives reward her for better firm performance and penalize her for diversification. This follows because diversification hurts firm value, as shown in equation (1). The penalty $\gamma n$ is the expected

[14] The second order condition is satisfied for $n$ and $\alpha$ positive. We show that $n$ and $\alpha$ are positive in equilibrium below.

loss in utility from a given level of diversification. We can think of $\gamma^*$ as the equilibrium expected cost to the manager of being fired given a unit increase in diversification. The expected cost of being fired is the product of the probability of being fired and the cost to the manager from being fired.

Additionally, given that $\gamma^* = \alpha^* - 1$, anything that increases incentives on firm performance also reduces in absolute value incentives against diversification. As a result, all of the comparative statics that we derive with respect to $\alpha^*$ will apply to $\gamma^*$ as well. Intuitively, when it is optimal to give the agent more performance-based incentives, this comes at the cost of exposing the agent to more risk. The greater risk exposure makes the agent more willing to trade some compensation for higher diversification. The optimal contract accommodates this by lowering the penalty for diversification.

Appendix A shows that $\alpha^*$ is the solution to the first order condition:

$$\frac{1-\alpha}{k} - \frac{2\alpha r\sigma^2}{z + \sqrt{(z^2 + 2r\sigma^2\alpha^2)}} = 0. \tag{9}$$

Optimal incentives $\alpha^*$ are a function of the exogenous parameters $r$, $\sigma^2$, $k$, and $z$. Using (9), we have the following comparative statics for the equilibrium choice of $\alpha^*(r, \sigma^2, k, z)$.

$$\frac{\partial\alpha^*}{\partial i} < 0, \quad i \in \{r, \sigma^2, k\} \quad \text{and}$$
$$\frac{\partial\alpha^*}{\partial z} > 0. \tag{10}$$

Managers receive fewer incentives as risk aversion or idiosyncratic variance increases.[15] This is an immediate consequence of assuming that managers are risk averse. Incentives decrease as the disutility of the action choice increases. As it becomes increasingly costly to induce the agent to take the action, the principal will respond by reducing the incentives she provides for the agent to take the action. Incentives increase as the private benefit associated with diversification $z$ increases. The intuition for this result is that the manager will increase diversification in response to the increased private benefit. With more diversification, it is less costly to provide the manager with performance-based incentives because diversification reduces the risk associated with incentives. Therefore, as private benefits increase, the manager can be given more incentives as part of the optimal contract to induce her to take more of the value-enhancing action.

To test the model based on the determinants of $\alpha^*$, we would need to observe the underlying structural parameters. For example, if we find that $\partial\alpha^*/\partial z > 0$, then this would constitute support for the private benefits explanation. Conversely, if we find that $\partial\alpha^*/\partial z < 0$, then we know that the private benefits explanation, at least in its basic form, is wrong. Unfortunately, $z$ is not directly

[15] Aggarwal and Samwick (1999, 2003), Himmelberg, Hubbard, and Palia (1999), and Jin (2002) show that $\partial\alpha^*/\partial\sigma^2 < 0$ is supported empirically. This is consistent with a standard principal–agent model. This result, however, does not uniquely identify the specific agency problem or even whether the agency problem pertains to firm diversification at all.

observable in a large cross section of firms. However, we can reliably observe $\pi$, $n$, and $\alpha$ in a large panel of firms. To test the theory, we therefore derive comparative static predictions of how these three endogenous outcomes will change as the underlying exogenous parameters $r$, $\sigma^2$, $k$, and $z$ vary across firms and over time.

We start by seeing how diversification is affected by incentives. For the agent's diversification choice, we use Proposition 1 to simplify $n^*$:

$$n^* = \frac{1}{2}z + \frac{1}{2}\sqrt{\left(z^2 + 2r\sigma^2(\alpha^*(r,\sigma^2,k,z))^2\right)}. \tag{11}$$

This is the optimal level of diversification. Note that, in the above equation, $z \geq 1$ is sufficient for $n^* \geq 1$. We calculate how $n^*(r, \sigma^2, z, \alpha^*)$ varies with respect to the exogenous parameters:

$$\begin{aligned} &\frac{\partial n^*}{\partial i} > 0, \quad i \in \{r, \sigma^2, z\} \quad \text{and} \\ &\frac{\partial n^*}{\partial k} < 0. \end{aligned} \tag{12}$$

As risk aversion and idiosyncratic variance increase, there are two effects. First, the manager attempts to reduce exposure directly through greater diversification, as can be seen in (11). Second, incentives decrease because exposure to risk is now more costly. The reduction in incentives will decrease diversification. The first effect outweighs the second (see Appendix A). As a result, when the manager's risk aversion increases or when idiosyncratic variance increases, the manager diversifies more. This is the first type of agency explanation of diversification—risk reduction for the manager. For the disutility of the action choice $k$, the optimal level of diversification changes only through the effect of $k$ on incentives $\alpha^*$. Because optimal incentives decrease as $k$ increases, diversification decreases. For private benefits of diversification $z$, the optimal level of diversification changes for two reasons. First, greater private benefits make diversification more attractive for managers, and this increases diversification. Second, as discussed above, greater private benefits increase incentives $\alpha^*$, and greater incentives in turn increase diversification. Therefore, both effects increase diversification. This is the second type of agency explanation of diversification—general private benefits.

Next we calculate how $n^*$ varies with $\alpha^*$ in equilibrium given changes in the exogenous parameters. Combining the above we have:

$$\begin{aligned} \left.\frac{\partial n^*}{\partial \alpha^*}\right|_{\partial r} &= \frac{\partial n^*}{\partial r} \Big/ \frac{\partial \alpha^*}{\partial r} < 0 \\ \left.\frac{\partial n^*}{\partial \alpha^*}\right|_{\partial \sigma^2} &= \frac{\partial n^*}{\partial \sigma^2} \Big/ \frac{\partial \alpha^*}{\partial \sigma^2} < 0 \\ \left.\frac{\partial n^*}{\partial \alpha^*}\right|_{\partial k} &= \frac{\partial n^*}{\partial k} \Big/ \frac{\partial \alpha^*}{\partial k} > 0 \\ \left.\frac{\partial n^*}{\partial \alpha^*}\right|_{\partial z} &= \frac{\partial n^*}{\partial z} \Big/ \frac{\partial \alpha^*}{\partial z} > 0. \end{aligned} \tag{13}$$

These comparative statics can be used to test the model.[16] These expressions relate the optimal level of diversification to the optimal amount of incentives given a change in an exogenous parameter. They do not represent what happens to diversification when there is an exogenous change in incentives. Our point is that incentives are not an exogenous variable—equilibrium incentives only change in response to a change in an exogenous parameter.

For risk aversion and idiosyncratic variance, diversification is decreasing in incentives. Increases in the cost of risk cause the principal to reduce the manager's exposure to risk by reducing incentives. Increases in the cost of risk also cause the manager to seek a higher level of diversification. For the disutility of the action choice, an increase in incentives is associated with an increase in diversification. A reduction in the disutility of the action makes incentives less costly to provide, which increases incentives. But greater incentives are met by an increase in diversification to try to offset the increased exposure to risk. For private benefits, an increase in incentives is also associated with an increase in diversification. When private benefits increase, managers choose higher levels of diversification. With greater diversification, managers are exposed to less risk. As a result, they can be provided with greater incentives.[17]

Equation (13) shows that the model permits the equilibrium relationship between diversification and incentives to be positive or negative, depending on the source of exogenous variation in the underlying parameters. An empirical estimate of the sign of $\partial n^*/\partial \alpha^*$ can indicate the underlying sources of variation and the motive responsible for observed differences in diversification. However, it is not sufficient to test the validity of our agency model of diversification, as our model has predictions for either sign. To test the model requires additional comparative static predictions. We turn now to firm value to provide those additional predictions.

[16] The results in equation (13) differ from differentiating equation (11) with respect to $\alpha$ in that equation (13) holds at the equilibrium choices of $(n^*, \alpha^*)$, whereas equation (11) describes $n^*$ as a function of $\alpha$.

[17] In principle, we could also see how the agent's action choice $x^*$ is affected by changes in the exogenous parameters. This is useful if the action choice is measurable (e.g., the action choice is investment—see Aggarwal and Samwick (2001) for a more thorough discussion of this case). It is not empirically useful if the action choice is not measurable (e.g., the action choice is effort, as in a standard principal-agent model). In addition, the equilibrium comparative statics with respect to $\alpha^*$ will not allow us to identify the underlying source of variation. The comparative statics for the agent's action choice $x^*$ with respect to the exogenous parameters are:

$$\frac{\partial x^*}{\partial i} < 0, \quad i \in \{r, \sigma^2, k\} \quad \text{and} \quad \frac{\partial x^*}{\partial z} > 0.$$

For a given source of exogenous variation:

$$\left.\frac{\partial x^*}{\partial \alpha^*}\right|_{\partial i} = \frac{\partial x^*}{\partial i} \Big/ \frac{\partial \alpha^*}{\partial i} > 0, \quad i \in \{r, \sigma^2, k, z\}.$$

In other words, the agent's action choice is always increasing in incentives regardless of the underlying source of exogenous variation.

It is clear that firm value depends on the exogenous parameters $r$, $\sigma^2$, $k$, and $z$ only through their impact on the agent's action $x$ and the agent's diversification choice $n$. We take the derivative of expected firm value $E(\pi)$ with respect to the exogenous parameters and then calculate how $E(\pi)$ varies with $\alpha^*$ and with $n^*$ given a change in the exogenous parameter. Expected firm value is given by

$$E(\pi) = x^* - n^* = \frac{\alpha^*}{k} - \frac{1}{2}z - \frac{1}{2}\sqrt{\left(z^2 + 2r\sigma^2(\alpha^*)^2\right)}, \tag{14}$$

where $\alpha^* = \alpha^*(r, \sigma^2, k, z)$. Expected firm value varies with the exogenous parameters in the following way:

$$\frac{\partial E(\pi)}{\partial i} < 0, \quad i \in \{r, \sigma^2, k, z\}. \tag{15}$$

These results are derived in Appendix A.

The results in (15) are intuitive. As risk aversion and idiosyncratic variance increase, firm value decreases because the optimal contract specifies that fewer incentives are given while at the same time diversification increases. As the disutility of the action choice increases, the agent receives fewer incentives so the agent takes less of the action, but also diversifies less. The first effect dominates the second, so firm value decreases. If the agent's private benefits of diversification increase, there are also two effects. First, diversification increases, which lowers firm value. Second, incentives increase, which leads the manager to take more of the action $x$, thereby raising firm value. The first effect dominates the second and so aggregate firm value is lowered.

Given a change in an exogenous parameter, firm value covaries with changes in $\alpha^*$ in the following ways:

$$\left.\frac{\partial E(\pi)}{\partial \alpha^*}\right|_{\partial i} = \frac{\partial E(\pi)}{\partial i} \Big/ \frac{\partial \alpha^*}{\partial i} > 0, \quad i \in \{r, \sigma^2, k\} \quad \text{and}$$
$$\left.\frac{\partial E(\pi)}{\partial \alpha^*}\right|_{\partial z} = \frac{\partial E(\pi)}{\partial z} \Big/ \frac{\partial \alpha^*}{\partial z} < 0. \tag{16}$$

If the underlying source of exogenous variation is risk aversion, idiosyncratic variance, or the disutility of the action choice, firm value is increasing in incentives. If the underlying source of variation is private benefits, then an increase in incentives is associated with a decrease in firm value because diversification will also increase.

We have for $n^*$

$$\left.\frac{\partial E(\pi)}{\partial n^*}\right|_{\partial i} = \frac{\partial E(\pi)}{\partial i} \Big/ \frac{\partial n^*}{\partial i} < 0, \quad i \in \{r, \sigma^2, z\} \text{ and}$$
$$\left.\frac{\partial E(\pi)}{\partial n^*}\right|_{\partial k} = \frac{\partial E(\pi)}{\partial k} \Big/ \frac{\partial \alpha^*}{\partial k} > 0. \tag{17}$$

The agent chooses a higher level of diversification than would the principal. Therefore, for risk aversion, idiosyncratic variance, and the private benefits of diversification, an increase in diversification reduces firm value. For the disutility of the action choice, a reduction in the disutility increases incentives sufficiently to increase firm value, even though diversification also increases.

To summarize, according to the theory, variation in firm performance, diversification, and incentives is the result of differences in the four underlying parameters—risk aversion, idiosyncratic variance, the disutility of the action choice, or private benefits of diversification. In equilibrium, we show how firm value is related to incentives and diversification and how diversification is related to incentives.

### *C. Identification*

We now consider how the model can be tested empirically. Equilibrium firm value is given by

$$\pi = x^*\big(\alpha^*\big(r, \sigma^2, k, z\big), k\big) - n^*(\alpha^*\big(r, \sigma^2, k, z\big), r, \sigma^2, z) + \varepsilon(n^*). \tag{18}$$

Firm value depends on incentives through the effect of incentives on both the action choice $x^*$ and diversification $n^*$. Because of this, the sign of the coefficient on incentives in a regression of firm value on incentives is ambiguous. Notice in equation (16) above that $\partial E(\pi)/\partial \alpha^*$ can be either positive or negative depending upon the source of exogenous variation. In addition, equation (17) shows that $\partial E(\pi)/\partial n^*$ can be either positive or negative depending upon the source of exogenous variation. However, if we condition on diversification, then firm value will be increasing in incentives. To see this, suppose we estimate equation (18) as follows:

$$\pi = \beta_0 + \beta_1 \alpha + \beta_2 n + \varepsilon, \tag{19}$$

where we use the fact that in our model $x^*$ is a positive function of $\alpha^*$. Then we should find $\beta_1 > 0$ and $\beta_2 < 0$ in all cases if the model is correct, regardless of the source of exogenous variation. Because diversification is in the regression, $\beta_1$ estimates the relationship between incentives and firm value only through the action choice $x^*$. Note also that our agency model of diversification will be rejected if we do not find $\beta_1 > 0$ and $\beta_2 < 0$ empirically. However, since both of these findings have been documented in prior literature, we do not regard these predictions by themselves as strong tests of our model.

In order to provide stronger tests of the model, we estimate and compare two empirical relationships. The first is the relationship between diversification and incentives. This is the relationship estimated in past tests of the agency explanations. The second is the difference in the relationship between firm value and incentives across firms that do and do not change levels of diversification. Regarding the first relationship, our model shows that if $\partial n^*/\partial \alpha^* < 0$, then the sources of exogenous variation that change incentives, diversification, and firm value are risk aversion or idiosyncratic variance. If $\partial n^*/\partial \alpha^* > 0$, then the sources of exogenous variation that change incentives, diversification, and firm value are either the level of private benefits that managers enjoy from running a diversified firm or the disutility of the action choice.

Regarding the second relationship, we identify a set of firms for which we know there has been a significant change in the underlying parameters—those for which diversification changes over the sample period. The source of variation can be identified by comparing $[\partial E(\pi)]/\partial\alpha^*$ across firms that do and do not change levels of diversification. Equation (16) shows that if the relationship between firm performance and incentives is stronger when there is a change in diversification, then the sources of exogenous variation that affect incentives, diversification, and firm value are risk aversion, idiosyncratic variance, or the disutility of the action choice. If the relationship between firm performance and incentives is weaker when there is a change in diversification, then the source of exogenous variation that affects incentives, diversification, and firm value is the level of private benefits that managers enjoy from running a diversified firm.

Our test of the agency model is whether the sources of variation in the underlying parameters identified by both empirical relationships are the same. Because these two relationships are equilibrium relationships, the model requires that they be driven by the same sources of variation in the underlying parameters (either the private benefits of diversification, a combination of risk aversion and idiosyncratic variance, or the disutility of the action choice). For example, if we find that $\partial n^*/\partial\alpha^* < 0$ and $[\partial E(\pi)]/\partial\alpha^*$ is lower for firms that experience changes in diversification than for firms that do not, then the model is falsified. The first result suggests variation in $r$ or $\sigma^2$, but the second result suggests variation in $z$.

To summarize, based on the comparative statics above, our model has four empirical predictions. First, controlling for the level of diversification, the model predicts that firm performance will be increasing in incentives. This is consistent with the evidence in Aggarwal and Samwick (2001).

Second, controlling for the level of incentives, the model predicts that firm performance will be decreasing in diversification. This is consistent with Lang and Stulz's (1994) evidence from the 1980s, Berger and Ofek (1995), Comment and Jarrell (1995), and Servaes (1996).

Third, if the underlying source of variation within firms is risk aversion or idiosyncratic variance, then diversification will be decreasing in incentives. If the underlying source of variation is the magnitude of the private benefits of diversification or the disutility of the manager's action choice, then diversification will be increasing in incentives.

Fourth, firms in which there are diversification changes are firms in which we know there have been large changes in an underlying parameter. If the underlying source of variation is risk aversion, idiosyncratic variance, or the disutility of the manager's action choice, performance will be even more strongly increasing in incentives than it will be for firms experiencing no change in diversification. Conversely, if the underlying source of variation is the magnitude of the private benefits of diversification, performance will be more weakly increasing (or potentially decreasing) in incentives than it will be for firms experiencing no change in diversification. Taken together, these predictions provide a test of the validity of our agency model of diversification.

## II. Data

This section describes the data sources that we use to test the comparative static predictions of our model. We use Standard and Poor's ExecuComp data set to construct our measure of managerial incentives. ExecuComp contains data on all aspects of compensation for the top five executives (ranked annually by salary and bonus) at each of the firms in the S&P 500, S&P Midcap 400, and S&P SmallCap 600. Due to enhanced federal reporting requirements for fiscal years ending after December 15, 1992, we can measure incentives from 1993 to 1998.[18] Financial and operating data for the ExecuComp sample companies are drawn from the COMPUSTAT data set. Monthly measures of stock returns from the Center for Research on Security Prices (CRSP) are utilized in calculations of the variance of returns.

Managers can receive pay–performance incentives from a variety of sources. The vast majority of these incentives are due to ownership of stock and stock options (Jensen and Murphy (1990), Aggarwal and Samwick (1999)). Much of the literature on the relationship between firm performance and incentives has considered incentives from stock ownership only. Our measure of incentives is more inclusive in that it also covers options. For this reason, we refer to our explanatory variable as the pay-performance sensitivity, or "PPS," rather than "ownership."

ExecuComp contains precise data on executives' holdings of stock in their own companies and grants of options during the current year. For stock, the pay–performance sensitivity is simply the fraction of the firm that the executive owns. A CEO who holds three percent of the stock outstanding in her firm will receive $30 per thousand dollar change in shareholder wealth. For options, the pay–performance sensitivity is the fraction of the firm's stock on which the options are written multiplied by the options' deltas.

For options granted in the current year, companies must report the number of options, the exercise price, and the exercise date. Following Standard and Poor's (1995), we assume that options will be exercised 80 percent through their term for options granted in 1994 or earlier. For example, if the term of the options is 10 years, we assume the options are exercised after 8 years. For option grants in 1995 and later, we assume the options will be exercised 70 percent through their term. The term structure of interest rates is obtained by interpolating the year-end Treasury yields for the 1-, 2-, 3-, 5-, 7-, 10-, and 30-year constant maturity series. In applying the Black–Scholes formula, we use the dividend yield for the company reported by ExecuComp and calculate the standard deviation of monthly stock returns for each company using data from CRSP. We use up to 5 years of prior monthly returns to compute variances. If a firm did not have at

[18] The ExecuComp data are collected directly from the companies' proxy statements and related filings with the Securities and Exchange Commission. Our analysis in this paper uses data from the October 1999 release of the data. See Standard and Poor's (1995) for further documentation.

least 12 prior monthly returns for a given year, we impute the variance.[19] We multiply this value by $\sqrt{12}$ to get the standard deviation of continuously compounded annual returns (volatility).

For options granted in previous years, the proxy statement reports only the aggregate number of securities and the aggregate "intrinsic value" of the options that are in the money. The intrinsic value of each option is the stock price at the end of the fiscal year less the option's exercise price—it corresponds to the value of the options if exercised immediately. Since the value of an option exceeds its intrinsic value, we estimate the value of options granted in prior years following the method of Murphy (1999). We treat all existing options as a single grant with a five-year remaining term and an exercise price such that the intrinsic value of all options is equal to that reported on the proxy statement. Apart from having to impute the exercise price and years remaining until exercise, the methodology for options granted in previous years is the same as for current option grants.

We exploit ExecuComp's sampling frame and examine the incentives to the top management team. CEO status is reported directly in ExecuComp and pertains to the executive who held that position for the majority of the year. The pay–performance sensitivity for the top management team is defined as the *PPS* for the CEO plus four times the average *PPS* of the other executives at the firm whose information is reported in a given year. This convention standardizes the size of the team at five for all firms, even if data are missing for some executives or more than five executives are reported in a given year.

The first two rows of Table I present descriptive statistics on the pay–performance sensitivities of the top management team and the CEO for the firms in our sample. The mean top management team has a combined pay–performance sensitivity equal to 7.2147 percent of the firm. The interpretation of this number is that if the value of shareholder wealth increases by $1000 over the course of a year, then the value of the stock and option holdings of the top management team will increase by $72.15. The distribution of management incentives across firms is skewed to the right, with median incentives substantially lower at 3.2164 percent. The CEO of each firm has incentives of 4.1930 percent of the firm at the mean and 1.3767 percent at the median. Other percentiles of the distributions are also reported, showing considerable variation in incentives in the ExecuComp sample.

The next row of Table I pertains to our measure of firm performance, Tobin's $Q$, which is calculated from COMPUSTAT. Tobin's $Q$ is equal to the ratio of the sum of the market value of equity and the book value of debt to the book value of assets. $Q$ is commonly used as a measure of firm performance (Morck, Shleifer, and Vishny (1988), McConnell and Servaes (1990), Himmelberg et al. (1999)). Our calculation reflects average $Q$ and abstracts from the effect of taxes on firm value. In our sample, the mean and median values of $Q$ are 2.14 and 1.60, respectively. The middle 80 percent of the firms have $Q$ values between 1.07 and 3.63.

[19] For firms that were missing data on variance for some years, we use the variance of the next available year's returns. For firms that had missing data on variance in all years, we use the sample's average variance in each year. Omitting these observations does not significantly change our results.

**Table I**

## Descriptive Statistics for Variables Used in Econometric Analyses

Pay–performance sensitivities (*PPS*) represent incentives provided by direct ownership of stock and stock options for each top management team or chief executive officer (CEO). They are expressed as percentages of the firm, from 0 to 100. Pay–performance sensitivities are calculated from ExecuComp. The *PPS* for the top management team includes the *PPS* for the CEO plus four times the average *PPS* for all other executives for whom data are available. Tobin's *Q* is equal to the ratio of the sum of the market value of equity and the book value of debt to the book value of assets. The number of segments is reported by company management in COMPUSTAT's Industry Segment file. The number of four-digit SICs and two-digit SICs are the number of different four- and two-digit Standard Industrial Classification (SIC) codes in which the firm operates. The rest of the variables are control variables included in our econometric specifications. All other variables are calculated from COMPUSTAT except for the standard deviation of monthly returns, which is based on dollar returns calculated from CRSP, expressed in millions. All dollar values are in millions of constant 1997 dollars. The sample is comprised of 1,602 firms observed in any year from 1993 to 1998.

| Variable | Number of observations | Mean | Standard deviation | 10th percentile | 25th percentile | Median | 75th percentile | 90th percentile |
|---|---|---|---|---|---|---|---|---|
| Team *PPS* | 7,045 | 7.2147 | 10.7724 | 0.4574 | 1.1766 | 3.2164 | 8.3049 | 19.6223 |
| CEO *PPS* | 7,045 | 4.1930 | 7.3855 | 0.1622 | 0.4776 | 1.3767 | 3.9659 | 11.8720 |
| Tobin's *Q* | 7,045 | 2.1397 | 2.1263 | 1.0666 | 1.2479 | 1.6002 | 2.3375 | 3.6263 |
| No. of Segments | 7,045 | 2.1807 | 1.8226 | 1.0000 | 1.0000 | 1.0000 | 3.0000 | 4.0000 |
| No. of four-digit SICs | 7,045 | 1.7916 | 1.2109 | 1.0000 | 1.0000 | 1.0000 | 2.0000 | 3.0000 |
| No. of two-digit SICs | 7,045 | 1.5516 | 0.9516 | 1.0000 | 1.0000 | 1.0000 | 2.0000 | 3.0000 |
| Investment/capital | 7,045 | 0.2543 | 0.1731 | 0.0845 | 0.1377 | 0.2106 | 0.3308 | 0.4815 |
| Dividend yield | 7,045 | 1.4928 | 2.1584 | 0.0000 | 0.0000 | 0.8700 | 2.3500 | 4.0200 |
| Ln(sales) | 7,045 | 7.0342 | 1.5832 | 5.1308 | 6.0369 | 6.9847 | 8.0879 | 9.0983 |
| Capital/sales | 7,045 | 0.5385 | 0.8911 | 0.0703 | 0.1318 | 0.2573 | 0.5576 | 1.4390 |
| Cash flow/capital | 7,045 | 0.8628 | 2.7421 | 0.1471 | 0.2461 | 0.4941 | 0.9321 | 1.8251 |
| Debt/assets | 7,015 | 0.2338 | 0.1818 | 0.0033 | 0.0828 | 0.2236 | 0.3472 | 0.4461 |
| Std. dev. of returns | 6,814 | 669.65 | 1491.69 | 61.70 | 106.20 | 235.82 | 601.38 | 1393.56 |
| R&D/capital | 3,815 | 0.3989 | 1.3003 | 0.0000 | 0.0120 | 0.0935 | 0.3647 | 0.9758 |
| Advertising/capital | 1,567 | 0.3216 | 0.8444 | 0.0226 | 0.0498 | 0.1219 | 0.3226 | 0.6579 |

Empirical measures of diversification have been based on data reported in the COMPUSTAT Industry Segment file. Firms are required to report disaggregated accounting information for any segment comprising 10 percent of the firm's sales. For these purposes, segments are defined to be components of an enterprise that provide a group of related products or services primarily to customers for a profit. There is some room for discretion as to how closely related a group of products must be in order to be classified in the same segment.

In light of this, we consider three measures of diversification, shown in the next three rows of Table I. The first is the number of segments reported by company management in COMPUSTAT's Industry Segment file. The mean number of segments is approximately two (2.1807) while the median is one segment. The second measure of diversification is the number of different four-digit Standard Industrial Classification (SIC) codes in which the firm operates. If a firm reports two or more segments whose products fall within the same four-digit SIC grouping, then we reclassify those segments to be the same segment for this measure. The mean number of four-digit SICs is 1.7916. The third measure of diversification further expands the definition of a segment to the reported two-digit SIC code. The mean number of two-digit SICs is 1.5516. These measures of diversification are similar to those used by Denis et al. (1997) and Comment and Jarrell (1995).[20] We report results for the number of different four-digit SICs. All three of our measures are highly correlated and all of our results are robust to the choice of measure. Approximately 60 percent of the firms in our sample are single-segment firms according to the four-digit SIC measure.

The remainder of Table I presents the descriptive statistics for other variables for which we control in our econometric specifications for $Q$ or diversification. We include investment, which is equal to capital expenditures for property, plant, and equipment divided by the stock of net property, plant, and equipment. We include the dividend yield to control for payout policy. We include the natural log of sales to account for differences in firm size. We include the ratio of capital (net property, plant, and equipment) to sales to control for asset turnover. In the regressions presented below, we also include the squares of these two variables. We include the ratio of cash flow to capital because many studies based on the work of Fazzari, Hubbard, and Petersen (1988) have shown a relationship between cash flow and investment. The effect of leverage is captured by the ratio of long-term debt to assets. We include the standard deviation of dollar returns to shareholders

[20] Those papers include three other measures of diversification: the fraction of firms with multiple segments, a revenue-based Herfindahl Index, and an asset-based Herfindahl Index. We exclude the first of these other three because it is useful primarily in Comment and Jarrell's (1995) time-series context. The analogous variable to use in a cross section, an indicator for whether the firm has multiple segments, is a very weak measure of diversification. We exclude the two Herfindahl measures because some of our estimates require us to analyze discrete changes in diversification, which can only be measured reliably by examining the number of segments. As in Denis et al. (1997) and Comment and Jarrell (1995), our results based on the level of diversification are invariant to the measure of diversification used. In their regression analysis, Denis et al. focus on the measures of diversification based on the number of segments.

(calculated from CRSP, as described above) to allow for an effect of risk on profitability and diversification. Finally, we include controls for the ratio of research and development to capital and advertising to capital.[21]

We restrict our sample to those firm-years in which team pay–performance sensitivity, diversification, and $Q$ can be constructed. Within that sample of 7,045 firm-years for 1,602 firms, the last four variables are missing for several hundred or more observations, as shown in the first column of Table I. In the empirical work below, we set the values of these variables to zero for observations where they are missing and include a dummy variable for whether the data were originally missing. This procedure allows us to use all of the information that is provided about the variables of interest without reducing the sample size due to missing data on the control variables.[22]

## III. Empirical Results

Our model predicts equilibrium relationships between firm performance, managerial incentives, and diversification. Our empirical tests of that model consist of regressions of Tobin's $Q$ on incentives and diversification and regressions of diversification on incentives. This design follows naturally from the theoretical model—managers choose the level of diversification as a function of their incentives, and firm performance is related to both diversification and incentives. However, it is important to recognize that the coefficients on incentives and diversification *do not* represent the marginal effect of an exogenous change in managerial incentives and diversification on firm performance. Instead, the estimated coefficients test the validity of the model by verifying that the endogenous relationships among the variables are consistent with the model's predictions based on shifts in a subset of the exogenous parameters.

### A. Initial Results

We begin by estimating regressions of the following form to test the first and second empirical predictions from Section I.B.:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2 n_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}. \qquad (20)$$

In this equation, the dependent variable is Tobin's $Q$. The independent variables are $PPS$ (incentives) and $n$ (diversification). The other covariates (listed in Table I)

[21] These variables are the same control variables used by Himmelberg et al. (1999) in their study of firm value and managerial ownership.

[22] If the firms where the variable is missing are different from the rest of the population in some systematic way, then the inclusion of a dummy variable identifying these firms controls for that difference. Observations in which data were originally missing for these control variables will contribute to the estimation of the coefficients of interest only to the extent that, within the group of observations with the missing data, there is a relationship between $Q$ and diversification and incentives.

are denoted by $x_{it}^k$. The specification also includes year effects, denoted by $\mu_t$, and firm level fixed effects, denoted by $\lambda_i$.

For each equation that we estimate, we report eight specifications. Tables II and III present the estimates of equation (20). Table II presents results for the top management team, and Table III presents results for CEOs. The CEO results are a robustness check for the results for the top management team. The first column in each table presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects (i.e., $\delta_k = 0, \forall k$ and $\lambda_i = 0, \forall i$). The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects. The most robust tests of the model include both the fixed effects and the other covariates. We show the other three results primarily to illustrate how the results are affected when potentially confounding factors are not controlled for in the regression.

In Table II, the coefficient on the *PPS* term is estimated to be positive in all of the specifications. It is more statistically significant, though smaller in size, when fixed effects are included. The coefficient on the diversification term is estimated to be negative and significant in all four specifications, consistent with the results in Lang and Stulz (1994), Berger and Ofek (1995), Comment and Jarrell (1995), and Servaes (1996). Table III provides essentially similar results for CEOs. The coefficient on the *PPS* term is estimated to be positive and significant in the first three regressions and positive but not significant in the regression that includes both fixed effects and other covariates.[23] The coefficient on the diversification term is estimated to be negative and significant in all four specifications, consistent with our results for the top management team.

The fixed effects regression establishes the relationships between performance and incentives and performance and diversification based only on changes within firms over time. The OLS regression establishes the relationships between performance and incentives and performance and diversification based on comparisons both within and across firms. If firms are not otherwise identical, the OLS regression will be biased by unobserved, firm-specific factors whereas the fixed effect regression will not. Comparing the adjusted $R^2$ from the first two regressions, the inclusion of the fixed effects absorbs a substantial amount of the variation (increasing the proportion of variance explained from 0.0633 to 0.8197), but the fixed effects do not change the sign of the predicted relationship.

[23] Prior studies by Morck et al. (1988), McConnell and Servaes (1990), and Himmelberg et al. (1999) have estimated the relationship between $Q$ and incentives. These studies find either no relationship or a nonmonotonic relationship using less recent or less comprehensive data. To investigate this possibility, we estimated piecewise-linear specifications of $Q$ on incentives. These specifications allow the relationship between $Q$ and incentives to differ over different ranges of incentives. In the regressions (not reported) for both the top management team and CEOs, we cannot reject the null hypothesis that the relationship between $Q$ and incentives is the same over all ranges of incentives. Thus, we do not find evidence of significant nonlinearities or nonmonotonicities in the data. In our linear specifications in Tables II and III, we find that $Q$ is increasing in incentives.

**Table II**

## Regressions of Tobin's *Q* on Top Management Incentives and Diversification

The regression specification is:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2 n_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}.$$

The dependent variable is Tobin's *Q*. The independent variables are top management incentives (*PPS*) and diversification ($n$—the number of four-digit SICs). The other covariates (listed in Table I) are denoted by $x_{it}^k$. The specification also includes year effects, denoted by $\mu_t$, and firm-level fixed effects, denoted by $\lambda_i$. The first column presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects. The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects. Each regression pertains to our sample of 1,602 firms and 7,045 firm-years. Heteroskedasticity-robust standard errors are reported in parentheses beneath each coefficient. Year effects are not reported to conserve space.

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Intercept | 2.2126 | 2.1703 | 5.2872 | 5.2467 |
| | (0.1726) | (0.0541) | (0.8719) | (1.2885) |
| *PPS* | 0.0377 | 0.0157 | 0.0277 | 0.0108 |
| | (0.0195) | (0.0040) | (0.0201) | (0.0035) |
| No. of four-digit SICs | – 0.2023 | – 0.0443 | – 0.0645 | – 0.0675 |
| | (0.0213) | (0.0177) | (0.0124) | (0.0196) |
| Investment | | | 2.3952 | 0.9901 |
| | | | (0.4439) | (0.1772) |
| Dividend yield | | | 0.0332 | – 0.0227 |
| | | | (0.0228) | (0.0171) |
| Ln(sales) | | | – 0.9812 | – 0.9474 |
| | | | (0.2226) | (0.3336) |
| Ln(sales)$^2$ | | | 0.0391 | 0.0811 |
| | | | (0.0145) | (0.0228) |
| Capital/sales | | | – 0.1951 | – 0.2939 |
| | | | (0.0531) | (0.0696) |
| (Capital/SALES)$^2$ | | | – 0.0007 | 0.0048 |
| | | | (0.0025) | (0.0024) |
| Cash flow/capital | | | 0.0190 | 0.0730 |
| | | | (0.0214) | (0.0226) |
| Debt/assets | | | – 0.8485 | – 0.9113 |
| | | | (0.1637) | (0.1752) |
| Missing D/A | | | 0.7077 | – 0.6681 |
| | | | (0.4319) | (0.4945) |
| CDF of std. dev. | | | 2.6813 | – 0.9616 |
| | | | (0.2125) | (0.2818) |
| Missing std. dev. | | | 1.9306 | – 0.3482 |
| | | | (0.4927) | (0.3003) |
| R&D/capital | | | – 0.0095 | 0.0397 |
| | | | (0.0642) | (0.0347) |
| Missing R&D/K | | | – 0.1510 | 0.0581 |
| | | | (0.0520) | (0.0906) |
| Advertising/capital | | | 0.0961 | – 0.2106 |
| | | | (0.1692) | (0.0766) |
| Missing Adv/K | | | – 0.1185 | – 0.0169 |
| | | | (0.0569) | (0.0588) |
| Adjusted *R*-squared | 0.0633 | 0.8197 | 0.2285 | 0.8294 |

**Table III**

## Regressions of Tobin's *Q* on CEO Incentives and Diversification

The regression specification is:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2 n_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}.$$

The dependent variable is Tobin's *Q*. The independent variables are CEO incentives (*PPS*) and diversification ($n$—the number of four-digit SICs). The other covariates (listed in Table I) are denoted by $x_{it}^k$. The specification also includes year effects, denoted by $\mu_t$, and firm-level fixed effects, denoted by $\lambda_i$. The first column presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects. The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects. Each regression pertains to our sample of 1,602 firms and 7,045 firm-years. Heteroskedasticity-robust standard errors are reported in parentheses beneath each coefficient. Year effects are not reported to conserve space.

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Intercept | 2.3876 | 2.2496 | 5.7547 | 5.4592 |
| | (0.0654) | (0.0514) | (0.8580) | (1.2919) |
| *PPS* | 0.0327 | 0.0090 | 0.0172 | 0.0034 |
| | (0.0090) | (0.0044) | (0.0072) | (0.0043) |
| No. of four-digit SICs | − 0.2254 | − 0.0410 | − 0.0659 | − 0.0643 |
| | (0.0128) | (0.0177) | (0.0116) | (0.0196) |
| Investment | | | 2.4860 | 1.0081 |
| | | | (0.5160) | (0.1785) |
| Dividend yield | | | 0.0243 | − 0.0235 |
| | | | (0.0150) | (0.0173) |
| Ln(sales) | | | − 1.0349 | − 0.9749 |
| | | | (0.2394) | (0.3344) |
| Ln(sales)$^2$ | | | 0.0409 | 0.0820 |
| | | | (0.0150) | (0.0228) |
| Capital/sales | | | − 0.2355 | − 0.3033 |
| | | | (0.0363) | (0.0698) |
| (Capital/sales)$^2$ | | | 0.0003 | 0.0051 |
| | | | (0.0021) | (0.0024) |
| Cash flow/capital | | | 0.0137 | 0.0726 |
| | | | (0.0247) | (0.0229) |
| Debt/assets | | | − 0.8836 | − 0.9060 |
| | | | (0.1595) | (0.1746) |
| Missing D/A | | | − 0.7015 | − 0.6694 |
| | | | (0.4447) | (0.4924) |
| CDF of std. dev. | | | 2.6205 | − 0.9740 |
| | | | (0.1786) | (0.2830) |
| Missing std. dev. | | | 1.9075 | − 0.3530 |
| | | | (0.4935) | (0.3027) |
| R&D/capital | | | − 0.0282 | 0.0407 |
| | | | (0.0722) | (0.0348) |
| Missing R&D/K | | | − 0.1161 | 0.0652 |
| | | | (0.0362) | (0.0909) |
| Advertising/capital | | | 0.1470 | − 0.2047 |
| | | | (0.2041) | (0.0773) |
| Missing Adv/K | | | − 0.1325 | − 0.0157 |
| | | | (0.0532) | (0.0590) |
| Adjusted $R$-squared | 0.0401 | 0.8192 | 0.2151 | 0.8291 |

The findings in Tables II and III are consistent with our model. Controlling for diversification, performance will be increasing in incentives in our model, independent of the source of exogenous variation (risk aversion, idiosyncratic variance, disutility of the action choice, and private benefits of diversification). Similarly, controlling for incentives, firm performance will be negatively related to diversification, independent of the source of exogenous variation.

### *B. Diversification and Incentives*

The third empirical prediction of our model from Section I.B pertains to the relationship between diversification and incentives. We estimate the following regression:

$$n_{it} = \beta_0 + \beta_1 PPS_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}. \tag{21}$$

In this equation, the dependent variable is diversification and the first independent variable is *PPS*. As in the *Q* regression, the other covariates are denoted by $x_{it}^k$, the year effects are denoted by $\mu_t$, and the firm-level fixed effects are $\lambda_i$. As noted in Section I, our theoretical framework can be consistent with either sign for $\beta_1$. If the underlying source of variation is the manager's private benefit from diversification $z$ or the disutility of the action choice $k$, then diversification will be positively related to incentives in equilibrium ($\beta_1 > 0$). Higher private benefits induce both more diversification and more incentives. Higher disutility of the action induces less incentives and so less need to diversify. If the underlying source of variation is risk aversion or idiosyncratic variance, then diversification and incentives will be negatively related ($\beta_1 < 0$). Higher values of these parameters will reduce equilibrium incentives and induce managers to increase diversification.

Tables IV and V present the results of the OLS and fixed-effect estimates of the coefficients in equation (21) for the top management team and CEOs. The initial regression in the first column of Table IV is an OLS specification that is similar to the regressions in Denis et al. (1997). Consistent with their results, we find that diversification is negatively related to incentives. The coefficient on the *PPS* term is $-0.016$ and is highly statistically significant. It is comparable in magnitude to the coefficient on ownership of $-0.013$ in Denis et al.'s first cross-sectional regression. This negative coefficient is the basis for the claim that private benefits are responsible for value-reducing diversification.

The other regressions show that this result is not robust to the inclusion of controls for other potentially confounding factors. In column 2, the inclusion of fixed effects reverses the sign on incentives, making it positive and significant. In column 3, we include additional covariates to control for firm-specific factors but omit the fixed effects. For this specification, the coefficient on the *PPS* term is estimated to be negative and insignificant, but significantly higher than in column 1 where the covariates are excluded. In column 4, we include the additional covariates and the fixed effects and find that the coefficient on the *PPS* term is estimated to be positive and significant and larger in magnitude than in the fixed effects specification without additional covariates in column 2. Table V presents results for CEOs. The signs and statistical significance of the estimated coefficients on the *PPS* terms are similar to those for the top management team in Table IV. Without fixed effects, a higher *PPS* is associated with lower diversification. However, when fixed effects are included, the relationship between *PPS* and diversification is positive.

This pattern in the coefficients across specifications strongly suggests that the results in Denis et al. (1997), in which higher equity ownership is associated with less diversification, are driven by omitted determinants of diversification that are correlated with managerial incentives. Adding in other covariates increases the coefficient on *PPS* toward zero. Including fixed effects, which control for the firm-specific average value of every unobserved factor, makes the relationship positive and significant. The fixed effects explain 66 percent of the variation in the number of segments, increasing the adjusted $R^2$ from 0.1753 to 0.8376 in the regressions including the other covariates in Table IV. This divergence between our results and those of Denis et al. can be explained by our ability to exploit the panel nature of our data to control for omitted firm-specific factors.

The positive estimated relationship between diversification and incentives in the fourth columns of Tables IV and V indicates that there is within-firm variation in the manager's level of private benefits $z$ or disutility of the action $k$. The estimates do not rule out the possibility that the other parameters of the model—$r$ or $\sigma^2$—are also varying. Indeed, the negative estimated relationship between diversification and incentives in the first columns of Tables IV and V suggests that there is variation in the risk variables across firms. In the third columns of Tables IV and V, controlling for a number of firm-specific factors including the standard deviation of firm returns eliminates the negative estimated relationship between diversification and incentives. In addition, to the extent that risk aversion is not time varying, the fixed effects specifications in the second and fourth columns will control for risk aversion. Our estimates suggest that while cross-sectional differences in risk aversion or firm variance may explain the relationship between the *level* of diversification and incentives, within-firm differences in private benefits or the disutility of the action choice explain *changes* in diversification and incentives. The positive coefficient on incentives in the fixed-effects specifications indicate that, to the extent that the risk variables are also shifting, their effects on diversification are outweighed by the shifts in the level of private benefits or the disutility of the action choice.

As shown in our model, the estimated coefficient on *PPS* does not represent the marginal change in diversification for an exogenous change in managerial incentives. For example, the coefficient of 0.0072 on incentives in Table IV does *not* imply that an increase in managerial incentives from five to fifteen percent ownership would *result* in an increase in the number of segments of 0.072. Instead, exogenous changes occur only in the underlying parameters, which we do not observe directly. A manager who has optimally been given incentives equal to fifteen percent of the firm has much larger private benefits $z$ or much smaller disutility of the action choice $k$ than a manager who has optimally been given

**Table IV**

## Regressions of Diversification on Top Management Incentives

The regression specification is:

$$n_{it} = \beta_0 + \beta_1 PPS_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}.$$

The dependent variable is diversification ($n$—the number of four-digit SICs). The first independent variable is top management incentives (*PPS*). The other covariates (listed in Table I) are denoted by $x_{it}^k$. The specification also includes year effects, denoted by $\mu_t$, and firm-level fixed effects, denoted by $\lambda_i$. The first column presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects. The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects. Each regression pertains to our sample of 1,602 firms and 7,045 firm-years. Heteroskedasticity-robust standard errors are reported in parentheses beneath each coefficient. Year effects are not reported to conserve space.

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Intercept | 2.0814 | 1.7669 | 1.6477 | 1.6632 |
| | (0.0494) | (0.0272) | (0.2015) | (0.3203) |
| *PPS* | – 0.0162 | 0.0051 | – 0.0014 | 0.0072 |
| | (0.0015) | (0.0018) | (0.0013) | (0.0019) |
| Investment | | | – 0.4973 | 0.0017 |
| | | | (0.1261) | (0.0878) |
| Dividend yield | | | 0.0749 | 0.0021 |
| | | | (0.0253) | (0.0045) |
| Ln(sales) | | | – 0.2303 | – 0.3010 |
| | | | (0.0609) | (0.1037) |
| Ln(sales)$^2$ | | | 0.0349 | 0.0487 |
| | | | (0.0046) | (0.0094) |
| Capital/sales | | | – 0.0658 | – 0.1233 |
| | | | (0.0329) | (0.0450) |
| (Capital/sales)$^2$ | | | 0.0018 | 0.0032 |
| | | | (0.0012) | (0.0013) |
| Cash flow/capital | | | – 0.0259 | – 0.0186 |
| | | | (0.0054) | (0.0062) |
| Debt/assets | | | 0.1435 | 0.1547 |
| | | | (0.0857) | (0.0830) |
| Missing D/A | | | – 0.3181 | 0.1489 |
| | | | (0.1134) | (0.0868) |
| CDF of std. dev. | | | – 0.2587 | – 0.4199 |
| | | | (0.0777) | (0.1186) |
| Missing std. dev. | | | – 0.1023 | – 0.1934 |
| | | | (0.0878) | (0.1079) |
| R&D/capital | | | – 0.0394 | – 0.0298 |
| | | | (0.0122) | (0.0158) |
| Missing R&D/K | | | 0.0336 | 0.0050 |
| | | | (0.0307) | (0.0158) |
| Advertising/capital | | | 0.1495 | 0.0466 |
| | | | (0.0339) | (0.0899) |
| Missing Adv/K | | | 0.3201 | – 0.0124 |
| | | | (0.0328) | (0.0295) |
| Adjusted $R$-squared | 0.0267 | 0.8312 | 0.1753 | 0.8376 |

**Table V**

## Regressions of Diversification on CEO Incentives

The regression specification is:

$$n_{it} = \beta_0 + \beta_1 PPS_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}.$$

The dependent variable is diversification ($n$—the number of four-digit SICs). The first independent variable is CEO incentives (*PPS*). The other covariates (listed in Table I) are denoted by $x_{it}^k$. The specification also includes year effects, denoted by $\mu_t$, and firm-level fixed effects, denoted by $\lambda_i$. The first column presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects. The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects. Each regression pertains to our sample of 1,602 firms and 7,045 firm-years. Heteroskedasticity-robust standard errors are reported in parentheses beneath each coefficient. Year effects are not reported to conserve space.

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Intercept | 2.0514 | 1.8001 | 1.6477 | 1.7684 |
| | (0.0490) | (0.0242) | (0.2017) | (0.3187) |
| *PPS* | – 0.0209 | 0.0017 | – 0.0025 | 0.0048 |
| | (0.0018) | (0.0019) | (0.0018) | (0.0020) |
| Investment | | | – 0.4989 | 0.0116 |
| | | | (0.1263) | (0.0883) |
| Dividend yield | | | 0.0748 | 0.0016 |
| | | | (0.0253) | (0.0044) |
| Ln(sales) | | | – 0.2297 | – 0.3157 |
| | | | (0.0611) | (0.1037) |
| Ln(sales)$^2$ | | | 0.0348 | 0.0493 |
| | | | (0.0046) | (0.0095) |
| Capital/sales | | | – 0.0661 | – 0.1281 |
| | | | (0.0329) | (0.0451) |
| (Capital/sales)$^2$ | | | 0.0012 | 0.0034 |
| | | | (0.0012) | (0.0013) |
| Cash flow/capital | | | – 0.0259 | – 0.0191 |
| | | | (0.0054) | (0.0061) |
| Debt/assets | | | 0.1429 | 0.1593 |
| | | | (0.0857) | (0.0831) |
| Missing D/A | | | – 0.3155 | 0.1490 |
| | | | (0.1135) | (0.0872) |
| CDF of std. dev. | | | – 0.2573 | – 0.4253 |
| | | | (0.0774) | (0.1188) |
| Missing std. dev. | | | – 0.1012 | – 0.1938 |
| | | | (0.0876) | (0.1081) |
| R & D/capital | | | – 0.0396 | – 0.0295 |
| | | | (0.0122) | (0.0159) |
| Missing R&D/K | | | 0.0335 | 0.0084 |
| | | | (0.0306) | (0.0898) |
| Advertising/capital | | | 0.1492 | 0.0519 |
| | | | (0.0338) | (0.0261) |
| Missing Adv/K | | | 0.3191 | – 0.0119 |
| | | | (0.0329) | (0.0296) |
| Adjusted $R$-squared | 0.0222 | 0.8310 | 0.1754 | 0.8373 |

incentives of five percent. The manager with the larger value of $z$ or smaller value of $k$ will be more inclined to diversify.

### C. Tests Based on Changes in Diversification

The knowledge that there is within-firm variation in the private benefits of diversification or the disutility of the action choice allows us to revisit the Tobin's $Q$ regressions to test the consistency of our model. We test the fourth empirical prediction from Section I.B by estimating the following regression:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2 (PPS_{it} \times \Delta_{it}) + \beta_3 \Delta_{it} + \beta_4 n_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}. \tag{22}$$

This equation is the same as equation (20), with the addition of two variables based on $\Delta$, which is a dummy variable for whether or not the firm has experienced a change in the level of diversification since the prior sample year. In this equation, the dependent variable is Tobin's $Q$. The key independent variables are *PPS* (incentives) and *PPS* interacted with $\Delta$. The coefficient on the interaction of *PPS* and $\Delta$ is the difference in the size of the relationship between *PPS* and $Q$ for firms that contemporaneously experience a change in diversification relative to the size of the relationship between *PPS* and $Q$ for firms that do not change their level of diversification. The sign of $\beta_2$ identifies the underlying source of variation within firms that causes changes in diversification.[24]

The intuition for this regression is that, according to the theory, changes in diversification must be caused by changes in the underlying parameters, $r$, $\sigma^2$, $k$, or $z$. Therefore, we use changes in diversification to proxy for a change in these parameters. Relative to firms that do not experience changes in diversification, firms in which there is a change in diversification have large changes in some underlying parameter. According to equation (16), the coefficient on the interaction of the *PPS* term with the dummy variable for a change in diversification $\beta_2$ should be positive if the change in diversification is caused by a change in $r$, $\sigma^2$, or $k$. The coefficient $\beta_2$ should be negative if the change in diversification is caused by a change in $z$.

An alternative way of stating this point is that, if the underlying source of variation is risk aversion, idiosyncratic variance, or the disutility of the action choice, then firms experiencing changes in diversification should have greater responses of performance to incentives than should firms that do not experience changes in diversification. Mathematically, $\beta_1 + \beta_2$ should be greater than $\beta_1$, because the additional variation in the parameters ($r$, $\sigma^2$, or $k$) that caused the change in diversification also cause the relationship between incentives and firm performance to be more positive. Conversely, if the underlying source of variation is the private benefit associated with diversification, then firms experiencing changes in diversification should have weaker responses of performance to

[24] We also include $\Delta$ in the regression directly to allow for the possibility that firms that change their number of segments have systematically different average values of Tobin's $Q$, regardless of their *PPS*, compared to firms that do not change their number of segments.

**Table VI**

## Regressions of Tobin's *Q* on Top Management Incentives Controlling for Changes in Diversification

The regression specification is:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2(PPS_{it} \times \Delta_{it}) + \beta_3 \Delta_{it} + \beta_4 n_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}.$$

The dependent variable is Tobin's *Q*. The first independent variable is top management incentives (*PPS*). The second independent variable is *PPS* interacted with a dummy variable $\Delta$ for whether or not the firm has experienced a change in the level of diversification since the prior sample year. The third independent variable is $\Delta$ itself, where $\Delta = 1$ if the number of four-digit SICs has changed this year (726 observations) and $\Delta = 0$ otherwise. The fourth independent variable is the level of diversification ($n$—the number of four-digit SICs). The other covariates (listed in Table I) are denoted by $x_{it}^k$. The specification also includes year effects, denoted by $\mu_t$, and firm-level fixed effects, denoted by $\lambda_i$. The first column presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects. The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects. Each regression pertains to our sample of 1,602 firms and 7,045 firm-years. Heteroskedasticity-robust standard errors are reported in parentheses beneath each coefficient. Year effects are not reported to conserve space. The bottom row presents the estimated coefficient on incentives for firms that experience a change in diversification, $\beta_1+\beta_2$. Below the sum is the $p$-value for the test that $\beta_1+\beta_2=0$; that is, the sum of the coefficients on incentives for firms that experience a change in diversification is not significantly different from zero.

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Intercept | 2.1641 | 2.1588 | 5.2504 | 5.2417 |
| | (0.1774) | (0.0547) | (0.8715) | (1.2861) |
| $\beta_1$ *PPS* | 0.0405 | 0.0166 | 0.0302 | 0.0116 |
| | (0.0208) | (0.0040) | (0.0212) | (0.0036) |
| $\beta_2$ $PPS \times \Delta$ | – 0.0465 | – 0.0107 | – 0.0418 | – 0.0086 |
| | (0.0208) | (0.0027) | (0.0202) | (0.0029) |
| $\Delta$ (Change in SICs) | – 0.0299 | 0.0039 | – 0.0201 | – 0.0132 |
| | (0.1160) | (0.0336) | (0.1069) | (0.0316) |
| No. of four-digit SICs | – 0.1868 | – 0.0423 | – 0.0515 | – 0.0643 |
| | (0.0199) | (0.0177) | (0.0122) | (0.0197) |
| Investment | | | 2.3771 | 0.9905 |
| | | | (0.4387) | (0.1780) |
| Dividend yield | | | 0.0330 | – 0.0227 |
| | | | (0.0225) | (0.0170) |
| Ln(sales) | | | – 0.9834 | – 0.9473 |
| | | | (0.2216) | (0.3330) |
| Ln(sales)$^2$ | | | 0.0390 | 0.0809 |
| | | | (0.0144) | (0.0227) |
| Capital/sales | | | – 0.2045 | – 0.2970 |
| | | | (0.0508) | (0.0695) |
| (Capital/sales)$^2$ | | | – 0.0004 | 0.0049 |
| | | | (0.0025) | (0.0024) |
| Cash flow/capital | | | 0.0174 | 0.0713 |
| | | | (0.0218) | (0.0227) |
| Debt/assets | | | – 0.8182 | – 0.9124 |
| | | | (0.1653) | (0.1751) |

**Table VI**—*continued*

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Missing D/A | | | 0.6951 | − 0.6683 |
| | | | (0.4319) | (0.4950) |
| CDF of std. dev. | | | 2.6957 | − 0.9612 |
| | | | (0.2140) | (0.2820) |
| Missing std. dev. | | | 1.9443 | − 0.3455 |
| | | | (0.4937) | (0.3008) |
| R&D/capital | | | − 0.0069 | 0.0401 |
| | | | (0.0623) | (0.0345) |
| Missing R&D/K | | | − 0.1379 | 0.0551 |
| | | | (0.0487) | (0.0909) |
| Advertising/capital | | | 0.1063 | − 0.2009 |
| | | | (0.1719) | (0.0765) |
| Missing Adv/K | | | − 0.1128 | − 0.0129 |
| | | | (0.0580) | (0.0588) |
| Adjusted $R$-squared | 0.0676 | 0.8198 | 0.2319 | 0.8295 |
| | Coefficient on incentives ($\Delta = 1$), $p$-value in [.] | | | |
| $\beta_1+\beta_2$ | − 0.0061 | 0.0060 | − 0.0117 | 0.0029 |
| $H_0$: = 0 | [0.133] | [0.179] | [0.039] | [0.489] |

incentives than should firms that do not experience changes in diversification. Mathematically, $\beta_1+\beta_2$ should be less than $\beta_1$, because the additional variation in the parameter ($z$) that caused the change in diversification also causes the relationship between incentives and firm performance to be less positive (or negative).

Tables VI and VII present the econometric estimates of the parameters in equation (22). Table VI presents results for the top management team, and Table VII presents results for CEOs. As in the earlier tables, the first column in each table presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects. The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects.

Table VI shows that the coefficient on the interaction of the *PPS* term with the dummy variable for a change in diversification $\beta_2$ is estimated to be negative and significant in all four regressions. This is consistent with private benefits associated with diversification being the primary underlying source of variation for firms that experience changes in diversification. The bottom panel of Table VI presents the estimated coefficient on incentives for firms that experience a change in diversification, $\beta_1+\beta_2$. This coefficient is $-0.0061$ for the OLS specification. Below the sum is the $p$-value for the test that $\beta_1+\beta_2=0$. This test does not reject the null—the sum of the coefficients on incentives for firms that experience a change in diversification is not significantly different from zero. For the fixed-effects specification, including the additional covariates in column 4, $\beta_1$ is positive and significant, $\beta_2$ is negative and significant, and $\beta_1+\beta_2$ is positive but insignificant. The results in Table VII for CEOs are similar to those in Table VI for the top management team. In all specifications, $\beta_1$ is positive and $\beta_2$ is negative.

**Table VII**

## Regressions of Tobin's *Q* on CEO Incentives Controlling for Changes in Diversification

The regression specification is:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2(PPS_{it} \times \Delta_{it}) + \beta_3 \Delta_{it} + \beta_4 n_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}.$$

The dependent variable is Tobin's *Q*. The first independent variable is CEO incentives (*PPS*). The second independent variable is *PPS* interacted with a dummy variable $\Delta$ for whether or not the firm has experienced a change in the level of diversification since the prior sample year. The third independent variable is $\Delta$ itself, where $\Delta = 1$ if the number of four-digit SICs has changed this year (726 observations) and $\Delta = 0$ otherwise. The fourth independent variable is the level of diversification ($n$—the number of four-digit SICs). The other covariates (listed in Table I) are denoted by $x_{it}^k$. The specification also includes year effects, denoted by $\mu_t$, and firm-level fixed effects, denoted by $\lambda_i$. The first column presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects. The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects. Each regression pertains to our sample of 1,602 firms and 7,045 firm-years. Heteroskedasticity-robust standard errors are reported in parentheses beneath each coefficient. Year effects are not reported to conserve space. The bottom row presents the estimated coefficient on incentives for firms that experience a change in diversification, $\beta_1 + \beta_2$. Below the sum is the $p$-value for the test that $\beta_1 + \beta_2 = 0$; that is, the sum of the coefficients on incentives for firms that experience a change in diversification is not significantly different from zero.

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Intercept | 2.3433 | 2.2429 | 5.7279 | 5.4617 |
| | (0.0676) | (0.0520) | (0.8552) | (1.2897) |
| $\beta_1$ *PPS* | 0.0347 | 0.0095 | 0.0187 | 0.0037 |
| | (0.0095) | (0.0044) | (0.0076) | (0.0043) |
| $\beta_2$ *PPS* x $\Delta$ | – 0.0471 | – 0.0131 | – 0.0355 | – 0.0105 |
| | (0.0107) | (0.0049) | (0.0099) | (0.0049) |
| $\Delta$ (Change in SICs) | – 0.1591 | – 0.0062 | – 0.1478 | – 0.0231 |
| | (0.0537) | (0.0337) | (0.0501) | (0.0313) |
| No. of four-digit SICs | – 0.2068 | – 0.0387 | – 0.0506 | – 0.0607 |
| | (0.0125) | (0.0178) | (0.0122) | (0.0197) |
| Investment | | | 2.4663 | 1.0065 |
| | | | (0.5129) | (0.1791) |
| Dividend yield | | | 0.0243 | – 0.0236 |
| | | | (0.0150) | (0.0172) |
| Ln(sales) | | | – 1.0382 | – 0.9750 |
| | | | (0.2389) | (0.3339) |
| Ln(sales)$^2$ | | | 0.0410 | 0.0818 |
| | | | (0.0150) | (0.0228) |
| Capital/sales | | | – 0.2419 | – 0.3059 |
| | | | (0.0362) | (0.0698) |
| (Capital/sales)$^2$ | | | 0.0005 | 0.0051 |
| | | | (0.0021) | (0.0024) |
| Cash flow/capital | | | 0.0131 | 0.0717 |
| | | | (0.0248) | (0.0230) |
| Debt/assets | | | – 0.8635 | – 0.9100 |
| | | | (0.1591) | (0.1745) |

**Table VII**—*continued*

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Missing D/A | | | 0.6897 | −0.6701 |
| | | | (0.4447) | (0.4928) |
| CDF of std. dev. | | | 2.6313 | −0.9741 |
| | | | (0.1792) | (0.2832) |
| Missing std. dev. | | | 1.9123 | −0.3522 |
| | | | (0.4934) | (0.3032) |
| R&D/capital | | | −0.0261 | 0.0414 |
| | | | (0.0710) | (0.0346) |
| Missing R&D/K | | | −0.1077 | 0.0625 |
| | | | (0.0359) | (0.0912) |
| Advertising/capital | | | 0.1510 | −0.1986 |
| | | | (0.2045) | (0.0774) |
| Missing Adv/K | | | −0.1292 | −0.0127 |
| | | | (0.0532) | (0.0590) |
| Adjusted $R$-squared | 0.0427 | 0.8192 | 0.2167 | 0.8291 |
| | Coefficient on incentives ($\Delta = 1$), $p$-value in [.] | | | |
| $\beta_1+\beta_2$ | −0.0124 | −0.0036 | −0.0169 | −0.0068 |
| $H_0$: = 0 | [0.006] | [0.569] | [0.008] | [0.287] |

They are highly significant in all specifications except fixed effects with covariates in column 4. The sum of the coefficients, $\beta_1+\beta_2$, is insignificant in the specifications that include fixed effects.

The results in Tables VI and VII provide a test of the model because they provide another piece of evidence regarding the source of underlying variation when diversification changes. Firms that experience diversification changes can have a less positive relationship between *PPS* and Tobin's $Q$ only if diversification changes are caused by changes in $z$. The agency model would be falsified if the source of variation for diversification changes identified in the fixed-effect regressions of diversification on incentives (Tables IV and V) were different from the source of variation identified by the regressions of Tobin's $Q$ on incentives, controlling for changes in diversification (Tables VI and VII). Instead, we find support for the agency model because both specifications indicate that the underlying source of variation within firms is the level of private benefits of diversification.

Our results for diversification can be distinguished from those in Aggarwal and Samwick (2001). That paper argues that managers do not overinvest in property, plant, and equipment as a result of private benefits associated with investment. The estimated positive relationship between Tobin's $Q$ and incentives, combined with an estimated positive relationship between investment and incentives, supports a model in which managers underinvest because investing imposes private costs (not benefits) on them. In that paper, there is no evidence that private benefits of investment drive the equilibrium outcomes for firm performance, the level of investment, and managerial incentives. The results in this paper show that diversification decisions are fundamentally different from investment decisions. Every year, firms engage in many investment projects of varying sizes and significance. Diversification decisions occur infrequently and are very large-scale decisions. The forces driving diversification decisions are naturally very different from those that drive investment decisions. Our results suggest that diversification decisions are driven by the private benefits managers receive from greater diversification.

As an additional robustness check, we examine whether our empirical results differ for firms that increase diversification as opposed to firms that decrease diversification. The theoretical predictions for the equilibrium comparative statics do not depend on the sign of the change in the underlying parameters. For example, an increase in $z$ leads to an increase in diversification, an increase in incentives, and a decrease in performance, resulting in a negative equilibrium relationship between performance and incentives for firms increasing their level of diversification. A decrease in $z$ leads to a decrease in diversification, a decrease in incentives, and an increase in performance, resulting in a negative equilibrium relationship between performance and incentives for firms decreasing their level of diversification. In both cases, the relationship between performance and incentives is negative for firms changing their level of diversification. We have therefore not distinguished between increases and decreases in diversification to establish our main results.

Table VIII shows the results of a univariate comparison of changes in incentives and $Q$ by whether firms increased or decreased their levels of diversification. Panel A presents the results for the top management team, and Panel B presents the results for CEOs. The rows identify what happened to the number of segments between the two years: stayed the same, decreased, or increased. The columns show the four possible combinations of how incentives and $Q$ change from year to year (incentives and $Q$ both down, incentives up and $Q$ down, incentives down and $Q$ up, and incentives and $Q$ both up). The first number in each cell is the number of observations, and the second number is the proportion of all of the given row's total observations that are in the cell.

The first row in each panel shows the proportion in each combination of incentives and $Q$ pertaining to firms that do not experience a change in diversification. There is slightly more probability of incentives and $Q$ changing in the same direction (the first and last columns) than in opposite directions (the middle two columns). This pattern is consistent with the positive relationship between $Q$ and incentives that we estimate in Tables VI and VII for firms that have no change in diversification. We use the first row as a basis for comparison with the other two rows in which diversification changes.

Our model suggests three sources of variation that could induce changes in diversification: the level of private benefits, $z$; risk aversion and variance of returns, $r\sigma^2$; and the disutility of the action choice, $k$. These sources of variation are matched to the cells in the tables.

For increases in diversification, incentives and $Q$ both down implies that variation comes from $r\sigma^2$, incentives up and $Q$ down implies that variation comes from $z$, incentives and $Q$ both up implies that variation comes from $k$, and incentives down and $Q$ up is not consistent with the theory. In both panels, the main difference between the row for increases in diversification and the row with no change in diversification is the substantially higher proportion of observations in which

**Table VIII**

**Univariate Comparison of Changes in Incentives and $Q$ by Whether Firms Increased or Decreased the Level of Diversification**

This table presents a univariate comparison of changes in incentives and Tobin's $Q$ by whether firms increased or decreased their levels of diversification. Panel A presents the results for the top management team, and Panel B presents the results for CEOs. The rows identify what happened to the number of segments between the two years: stayed the same, decreased, or increased. The columns show the four possible combinations of how incentives and $Q$ change from year to year (incentives and $Q$ both down, incentives up and $Q$ down, incentives down and $Q$ up, and incentives and $Q$ both up). The first number in each cell is the number of observations, and the second number is the proportion of all of the given row's total observations that are in the cell. Our model suggests three sources of variation that could induce changes in diversification: the level of private benefits, $z$; risk aversion and variance of returns, $r\sigma^2$; and the disutility of the action choice, $k$. These sources of variation are matched to the cells in the table that exhibit the corresponding changes in diversification, incentives, and $Q$. There are 5,443 observations in each panel because, for every observation, we need a pair of years to make the comparison for the number of segments.

| Number of segments, compared to previous year | Incentives lower, Tobin's $Q$ lower | Incentives higher, Tobin's $Q$ lower | Incentives lower, Tobin's $Q$ higher | Incentives higher, Tobin's $Q$ higher | Total |
|---|---|---|---|---|---|
| **Panel A: Univariate Comparison for Top Management Team** | | | | | |
| No change | 1,205 | 1,098 | 1,110 | 1,304 | 4,717 |
| | 25.55 | 23.28 | 23.53 | 27.64 | |
| More segments | 103 | 130 | 58 | 109 | 400 |
| | 25.75 | 32.50 | 14.50 | 27.25 | |
| | $r\sigma^2$ | $z$ | | $k$ | |
| Fewer segments | 65 | 71 | 69 | 121 | 326 |
| | 19.94 | 21.78 | 21.17 | 37.12 | |
| | $k$ | | $z$ | $r\sigma^2$ | |
| **Panel B: Univariate Comparison for CEOs** | | | | | |
| No change | 1,062 | 1,241 | 973 | 1,441 | 4,717 |
| | 22.51 | 26.31 | 20.63 | 30.55 | |
| More segments | 95 | 138 | 53 | 114 | 400 |
| | 23.75 | 34.50 | 13.25 | 28.50 | |
| | $r\sigma^2$ | $z$ | | $k$ | |
| Fewer segments | 56 | 80 | 60 | 130 | 326 |
| | 17.18 | 24.54 | 18.40 | 39.88 | |
| | $k$ | | $z$ | $r\sigma^2$ | |

incentives are higher and $Q$ is lower. This is consistent with the primary source of variation being changes in private benefits when diversification increases.

For decreases in diversification, incentives and $Q$ both down implies that variation comes from $k$; incentives down and $Q$ up implies that variation comes from $z$; incentives and $Q$ both up implies that variation comes from $r\sigma^2$; and incentives up and $Q$ down is not consistent with the theory. In both panels, the main difference between the row for decreases in diversification and the row with no change in diversification is the substantially higher proportion of observations in which incentives are higher and $Q$ is higher. This is consistent with the primary sources of variation being changes in risk aversion and the variance of returns when diversification decreases.

The univariate comparison does not control for other factors such as firm characteristics, sales, cash flow, and capital structure that affect the relationship between incentives and $Q$. For these reasons, in Tables IX and X, we present analogous results to those in Tables VI and VII to show that our empirical results are similar for firms that increase diversification and firms that decrease diversification. We estimate the following regression:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2 \left(PPS_{it} \times \Delta_{it}^{up}\right) + \beta_3 \left(PPS_{it} \times \Delta_{it}^{down}\right) + \beta_4 \Delta_{it}^{up} + \beta_5 \Delta_{it}^{down} + \beta_6 n_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}. \tag{23}$$

Equation (23) replaces the variable $\Delta$, which indicated any change in the number of segments, with the two variables, $\Delta^{up}$ and $\Delta^{down}$, which indicate increases and decreases in the number of segments, respectively. In our sample of 7,045 observations, 10.31 percent are firm-years in which diversification changed. There are 400 increases in the number of four-digit SICs and 326 decreases in the number of four-digit SICs. Approximately 40 percent of the sample firms experience a change in the number of four-digit SICs over the sample period.

Table IX shows the results for the top management team, and Table X shows the results for CEOs. The estimates of $\beta_1$ are similar to the corresponding values in Tables VI and VII. Similarly, the coefficient on the number of segments is negative and significant in all regressions, and neither variable, $\Delta^{up}$ or $\Delta^{down}$, is statistically significant in any regression. In all regressions, the coefficient on $PPS \times \Delta^{up}$ is negative and significant. These coefficients are larger in magnitude and of similar statistical significance to the coefficients on $PPS \times \Delta$ in Tables VI and VII. The coefficients on $PPS \times \Delta^{down}$ are negative in all regressions, with a somewhat lower magnitude and statistical significance than the coefficients on $PPS \times \Delta$ in Tables VI and VII. Thus, the main result that firms which experience diversification changes have a weaker relationship between firm performance and incentives continues to hold when disaggregated by the direction of the change.[25]

[25] While the univariate results in Table VIII for increases in diversification tell the same story as the regression results in Tables IX and X, the univariate results for decreases in diversification do not. There are two reasons for this disparity. First, as noted above, the univariate comparison does not control for other factors that may affect the relationship between incentives and firm performance. Second, the proportion in each column in Table VIII captures only a portion of what the regressions in Tables IX and X estimate. The regression coefficients are also determined by the magnitudes of the correlations between the changes in incentives and $Q$. The negative estimates for $\beta_3$ in the regressions imply that, for those observations in which there is a negative correlation between $Q$ and incentives, this correlation is large in magnitude. The high proportion of observations in which incentives and $Q$ are positively correlated contributes to the weaker negative correlation between incentives and $Q$ for diversification decreases relative to diversification increases that we estimate in Tables IX and X.

**Table IX**

## Regressions of Tobin's $Q$ on Top Management Incentives Controlling for Increases and Decreases in Diversification

The regression specification is:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2(PPS_{it} \times \Delta_{it}^{up}) + \beta_3(PPS_{it} \times \Delta_{it}^{down}) + \beta_4 \Delta_{it}^{up} + \beta_5 \Delta_{it}^{down} + \beta_6 n_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}.$$

The dependent variable is Tobin's $Q$. The first independent variable is top management incentives (*PPS*). The second independent variable is *PPS* interacted with a dummy variable $\Delta^{up}$ for whether or not the firm has experienced an increase in the level of diversification since the prior sample year. The third independent variable is *PPS* interacted with a dummy variable $\Delta^{down}$ for whether or not the firm has experienced a decrease in the level of diversification since the prior sample year. The fourth independent variable is $\Delta^{up}$ itself, where $\Delta^{up} = 1$ if the number of four-digit SICs has increased this year (400 observations) and $\Delta^{up} = 0$ otherwise. The fifth independent variable is $\Delta^{down}$ itself, where $\Delta^{down} = 1$ if the number of four-digit SICs has decreased this year (326 observations) and $\Delta^{down} = 0$ otherwise. The sixth independent variable is the level of diversification ($n$—the number of four-digit SICs). The other covariates (listed in Table I) are denoted by $x_{it}^k$. The specification also includes year effects, denoted by $\mu_t$, and firm-level fixed effects, denoted by $\lambda_i$. The first column presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects. The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects. Each regression pertains to our sample of 1,602 firms and 7,045 firm-years. Heteroskedasticity-robust standard errors are reported in parentheses beneath each coefficient. Year effects are not reported to conserve space in all specifications. The other covariates are included but not reported in columns 3 and 4 to conserve space. The bottom panel presents three tests. The first, $\beta_2 - \beta_3$, tests for differences in the effect of increases in diversification interacted with incentives versus decreases in diversification interacted with incentives on firm performance. The second, $\beta_1+\beta_2$, presents the estimated coefficient on incentives for firms that experience an increase in diversification. The third, $\beta_1+\beta_3$, presents the estimated coefficient on incentives for firms that experience a decrease in diversification. For each test, $p$-values are reported in [.].

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Intercept | 2.1664 | 2.1446 | 5.2507 | 5.2088 |
| | (0.1786) | (0.0613) | (0.8717) | (1.2856) |
| $\beta_1$ *PPS* | 0.0404 | 0.0165 | 0.0302 | 0.0115 |
| | (0.0208) | (0.0040) | (0.0212) | (0.0036) |
| $\beta_2$ *PPS* × Δ-up | – 0.0561 | – 0.0207 | – 0.0445 | – 0.0193 |
| | (0.0210) | (0.0060) | (0.0186) | (0.0055) |
| $\beta_3$ *PPS* × Δ-down | – 0.0417 | – 0.0061 | – 0.0405 | – 0.0038 |
| | (0.0211) | (0.0028) | (0.0217) | (0.0031) |
| Δ-up | 0.0352 | 0.0267 | – 0.0003 | 0.0213 |
| | (0.1144) | (0.0557) | (0.1073) | (0.0510) |
| Δ-down | – 0.0760 | 0.0011 | – 0.0348 | – 0.0263 |
| | (0.1366) | (0.0377) | (0.1196) | (0.0381) |
| No. of four-digit SICs | – 0.1880 | – 0.0340 | – 0.0519 | – 0.0597 |
| | (0.0205) | (0.0228) | (0.0123) | (0.0243) |
| Adjusted $R$-squared | 0.0674 | 0.8199 | 0.2317 | 0.8295 |
| | Coefficient on incentives (Δ-up, Δ-down = 1), $p$-value in [.] | | | |
| $\beta_2 - \beta_3$ | – 0.0144 | – 0.0146 | – 0.0040 | – 0.0155 |
| $H_0$: = 0 | [0.042] | [0.021] | [0.700] | [0.011] |
| $\beta_1+\beta_2$ | – 0.0157 | – 0.0042 | – 0.0143 | – 0.0078 |
| $H_0$: = 0 | [0.005] | [0.539] | [0.075] | [0.217] |
| $\beta_1+\beta_3$ | – 0.0013 | 0.0104 | – 0.0103 | 0.0078 |
| $H_0$: = 0 | [0.772] | [0.022] | [0.138] | [0.082] |

**Table X**

## Regressions of Tobin's *Q* on CEO Incentives Controlling for Increases and Decreases in Diversification

The regression specification is:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2(PPS_{it} \times \Delta_{it}^{up}) + \beta_3(PPS_{it} \times \Delta_{it}^{down}) + \beta_4 \Delta_{it}^{up} + \beta_5 \Delta_{it}^{down} + \beta_6 n_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \mu_t + \lambda_i + \varepsilon_{it}.$$

The dependent variable is Tobin's *Q*. The first independent variable is CEO incentives (*PPS*). The second independent variable is *PPS* interacted with a dummy variable $\Delta^{up}$ for whether or not the firm has experienced an increase in the level of diversification since the prior sample year. The third independent variable is *PPS* interacted with a dummy variable $\Delta^{down}$ for whether or not the firm has experienced a decrease in the level of diversification since the prior sample year. The fourth independent variable is $\Delta^{up}$ itself, where $\Delta^{up} = 1$ if the number of four-digit SICs has increased this year (400 observations) and $\Delta^{up} = 0$ otherwise. The fifth independent variable is $\Delta^{down}$ itself, where $\Delta^{down} = 1$ if the number of four-digit SICs has decreased this year (326 observations) and $\Delta^{down} = 0$ otherwise. The sixth independent variable is the level of diversification ($n$—the number of four-digit SICs). The other covariates (listed in Table I) are denoted by $x_{it}^k$. The specification also includes year effects, denoted by $\mu_t$, and firm-level fixed effects, denoted by $\lambda_i$. The first column presents the OLS estimates of the coefficients, excluding the other covariates and the fixed effects. The second column includes the fixed effects but not the other covariates. The third column includes the other covariates but not the fixed effects. The fourth column includes both the other covariates and the fixed effects. Each regression pertains to our sample of 1,602 firms and 7,045 firm-years. Heteroskedasticity-robust standard errors are reported in parentheses beneath each coefficient. Year effects are not reported to conserve space in all specifications. The other covariates are included but not reported in columns 3 and 4 to conserve space. The bottom panel presents three tests. The first, $\beta_2 - \beta_3$, tests for differences in the effect of increases in diversification interacted with incentives versus decreases in diversification interacted with incentives on firm performance. The second, $\beta_1 + \beta_2$, presents the estimated coefficient on incentives for firms that experience an increase in diversification. The third, $\beta_1 + \beta_3$, presents the estimated coefficient on incentives for firms that experience a decrease in diversification. For each test, *p*-values are reported in brackets.

| Variable | OLS | Fixed effect | OLS w/controls | FE w/controls |
|---|---|---|---|---|
| Intercept | 2.3453 | 2.2287 | 5.7278 | 5.4491 |
| | (0.0682) | (0.0589) | (0.8554) | (1.2889) |
| $\beta_1$ *PPS* | 0.0347 | 0.0095 | 0.0187 | 0.0037 |
| | (0.0095) | (0.0044) | (0.0076) | (0.0043) |
| $\beta_2$ *PPS* × Δ-up | – 0.0526 | – 0.0208 | – 0.0400 | – 0.0209 |
| | (0.0122) | (0.0082) | (0.0137) | (0.0080) |
| $\beta_3$ *PPS* × Δ-down | – 0.0428 | – 0.0083 | – 0.0322 | – 0.0038 |
| | (0.0112) | (0.0051) | (0.0105) | (0.0051) |
| Δ-up | – 0.1179 | – 0.0079 | – 0.1310 | – 0.0094 |
| | (0.0767) | (0.0558) | (0.0713) | (0.0509) |
| Δ-down | – 0.1993 | – 0.0007 | – 0.1627 | – 0.0314 |
| | (0.0640) | (0.0377) | (0.0590) | (0.0377) |
| No. of four-digit SICs | – 0.2078 | – 0.0309 | – 0.0509 | – 0.0563 |
| | (0.0126) | (0.0230) | (0.0124) | (0.0244) |
| Adjusted $R$-squared | 0.0425 | 0.8192 | 0.2165 | 0.8291 |
| Coefficient on incentives (Δ-up, Δ-down = 1), *p*-value in [.] | | | | |
| $\beta_2 - \beta_3$ | – 0.0097 | – 0.0125 | – 0.0078 | – 0.0170 |
| $H_0$: = 0 | [0.290] | [0.161] | [0.555] | [0.051] |
| $\beta_1 + \beta_2$ | – 0.0179 | – 0.0113 | – 0.0214 | – 0.0171 |
| $H_0$: = 0 | [0.018] | [0.216] | [0.059] | [0.056] |
| $\beta_1 + \beta_3$ | – 0.0081 | 0.0012 | – 0.0135 | – 0.0001 |
| $H_0$: = 0 | [0.127] | [0.857] | [0.059] | [0.989] |

## IV. Discussion

Our theoretical framework is general enough to incorporate the two agency explanations for diversification from the existing literature. It allows contracts to be based on both the performance of the firm and the level of diversification. We can examine the importance of each of these features of our model in light of our empirical results and the extended comparative statics in Appendix B. Each appendix table relaxes a subset of these assumptions. In Table B1, we assume that the level of diversification is not contractible, and in Table B2, we assume that the level of diversification is contractible. Within each table, the first case assumes only a private benefit, the second case assumes only risk reduction, and the third case assumes that managers enjoy both a private benefit and risk reduction through diversification. Case 6 is the one derived in Section I.

Our first conclusion is that the model generates the same key comparative statics regardless of whether $n$ is contractible. Comparing Case 3 and Case 6, all of the comparative static predictions for $r$, $\sigma^2$, and $z$ are the same when the compensation contract does not include the level of diversification as when it does. Although the comparative static predictions for $k$ are different, our empirical result that $[\partial E(\pi)]/\partial\alpha$ is lower for firms that experience changes in diversification is sufficient to reject variation in $k$ in either case. Therefore, our interpretation of the empirical results—that changes in diversification are the result of shifts in private benefits—is robust to the possibility that firms do not incorporate the level of diversification into their managerial compensation contracts.

Our second conclusion is that there is no way to explain all of our empirical results using the comparative static predictions of a model that excludes private benefits altogether. Case 5 shows the predictions of the model assuming that the only benefit to diversification is through risk reduction. Our empirical results show it is not possible to reconcile the data with the predictions from Case 5, in which the sources of variation are limited to $r$, $\sigma^2$, or $k$. Specifically, the model without private benefits cannot generate the prediction that $[\partial E(\pi)]/\partial\alpha$ is lower for firms that experience changes in diversification. In the agency framework, private benefits of diversification are essential.

Our third conclusion is that the agency model does not necessarily need to incorporate risk reduction as a motive for diversification. When the level of diversification is not contractible, then all comparative static predictions are the same regardless of whether the model includes only the private benefits of diversification (Case 1) or the private benefits in addition to risk reduction (Case 3). When the level of diversification is contractible, the comparative static predictions with no risk reduction motive (Case 4) are either zero or of the same sign as those in the model with private benefits and risk reduction (Case 6) for all sources of variation except $k$, which is again ruled out empirically. Thus, apart from the interior solutions that are present in the models where $n$ is contractible, nothing is lost if the risk-reduction motive is omitted from the model.

Our fourth conclusion is that May's (1995) inference that a positive relationship between diversification and incentives constitutes support for the risk-reduction motive is not warranted.[26] To understand why, suppose that managers diversify solely to reduce risk. May's intuition is that managers with greater incentives seek more diversification, assuming there is no variation in risk aversion or idiosyncratic variance. However, our model shows that the magnitude of managerial incentives is related to the manager's risk aversion and idiosyncratic variance. In equilibrium, those managers who have a greater need for risk reduction (i.e., those with high risk aversion or high idiosyncratic variance) are the ones who will have lower incentives. These are also the managers who will diversify more to offset their risk exposure. In equilibrium, the relationship between diversification and incentives will be negative if risk reduction is the motive for diversification. Empirically, both we and May find that the relationship between diversification and incentives is positive, not negative.

Our fifth conclusion is that the existing evidence for the private benefits explanation is tenuous. Denis, Denis, and Sarin (1997) infer that a negative relationship between diversification and incentives constitutes support for the private benefits motive. Our model shows that such a conclusion is not warranted. If managers have private benefits of diversification, in equilibrium, those managers with greater private benefits will receive more incentives and will diversify more. In the data, we observe a positive relationship between diversification and incentives.

## V. Conclusion

In this paper, we integrate the two agency explanations of diversification—risk reduction and private benefits—into a single model. We derive equilibrium comparative static predictions for the relationships between three endogenous variables—firm performance, diversification, and incentives. Considered jointly, observed changes in these endogenous variables identify the underlying source of variation in the exogenous parameters: risk aversion, idiosyncratic variance, the manager's disutility of taking actions, or the private benefits managers receive from diversifying. Our model provides us with specific predictions as to the nature of these estimated relationships. Without an equilibrium model, it is not possible to consistently interpret what these relationships mean.

Consistent with previous studies, we find that firm performance is increasing in incentives and decreasing in diversification. By carefully controlling for firm-specific factors that influence diversification, we also find evidence that diversification is positively related to incentives. This result suggests that when managers' private benefits from diversification increase, in equilibrium, both incentives and diversification increase.

[26] May (1995) demonstrates that among firms making acquisitions, those in which managers have more ownership seek more diversification through their acquisitions than those in which managers have less ownership. His proxy for the desire for risk reduction is the degree of (negative) correlation between the acquirer and target. This measure of the desire for risk reduction is higher when the acquirer and target are unrelated. Private benefits of diversification are also higher when the segments are less related. As a result, May cannot uniquely identify a risk reduction motive for diversification.

In addition, our theory predicts that firms in which managers experience shifts in private benefits will have weaker responses of performance to incentives. When we examine firms that experience changes in diversification, we find that these firms have essentially no response of performance to incentives. This finding is consistent with the positive estimated relationship between diversification and incentives. Both are caused by exogenous shifts in the private benefits associated with diversification.

Our findings suggest that diversification is indeed related to agency problems, but in a much different way than has been explored in the literature. Our evidence does not support the idea that managers diversify their firms to reduce their exposure to risk. Instead, our findings strongly suggest a role for private benefits of diversification. In equilibrium, firms in which managers experience an increase in the private benefits of diversification will have managers with greater incentives, will diversify more, and will show weaker responses of performance to incentives.

## Appendix A

*Proof of Proposition 1:*

The first-order condition for $\gamma$ is

$$\frac{1}{2}\left(-1+\frac{z}{\frac{1}{(2\alpha-2\gamma)}(z+\psi)}+\frac{\alpha^2 r\sigma^2}{2\left(\frac{1}{(2\alpha-2\gamma)}(z+\psi)\right)^2}\right)\frac{\psi z+z^2+r\sigma^2\alpha^3-r\sigma^2\alpha^2\gamma}{(\alpha-\gamma)^2\psi}=0, \quad \text{(A1)}$$

where $\psi=\sqrt{(z^2+2r\sigma^2\alpha^3-2r\sigma^2\alpha^2\gamma)}$.

It is straightforward to verify that $\gamma^*=\alpha-1$ solves the first-order condition. Some algebra demonstrates that the second order condition is negative at $\gamma^*=\alpha-1$.

The first order condition for $\alpha$ is:

$$\frac{1-\alpha}{k}-\frac{\alpha r\sigma^2}{\frac{1}{(2\alpha-2\gamma)}(z+\psi)}+\left(-1+\frac{z}{\frac{1}{(2\alpha-2\gamma)}(z+\psi)}+\frac{\alpha^2 r\sigma^2}{2\left(\frac{1}{(2\alpha-2\gamma)}(z+\psi)\right)^2}\right)\frac{\partial n}{\partial\alpha}=0, \quad \text{(A2)}$$

where

$$\frac{\partial n}{\partial\alpha}=-\frac{1}{2}\,\frac{\psi z+z^2-r\sigma^2\alpha^3+3r\sigma^2\alpha^2\gamma-2r\sigma^2\alpha\gamma^2}{(\alpha-\gamma)^2\psi}. \quad \text{(A3)}$$

Using the fact that $\gamma^*=\alpha-1$, this first-order condition reduces to:

$$\frac{1-\alpha}{k}-\frac{2\alpha r\sigma^2}{z+\sqrt{(z^2+2r\sigma^2\alpha^2)}}=0. \quad \text{(A4)}$$

At $\alpha = 0$, the first-order condition is:

$$\frac{1}{k} > 0. \tag{A5}$$

At $\alpha = 1$, the first order condition is:

$$-\frac{2r\sigma^2}{z + \sqrt{(z^2 + 2r\sigma^2)}} < 0. \tag{A6}$$

Therefore, there exists an interior solution on (0,1). Some algebra shows that the second-order condition generated from (A2) is negative for $\gamma^* = \alpha - 1$ and for all $\alpha \in (0,1)$, implying that the solution is unique. ■

To see that $\partial n^*/\partial r > 0$ and $\partial n^*/\partial \sigma^2 > 0$, first note that $r\sigma^2$ appears together in all expressions. Therefore, we can define $\theta = r\sigma^2$ and then calculate $\partial n^*/\partial \theta$:[27]

$$\frac{\partial n^*}{\partial \theta} = \frac{1}{2}\alpha^2 \times \frac{2\theta^2\alpha^4 - 4\theta^2\alpha^2 kz + 5z^2\theta\alpha^2 + 3\theta\alpha^2\phi z - 2\theta\phi kz^2 - 2\theta kz^3 + 2z^4 + 2\phi z^3 - 2\theta^2 k\phi\alpha^2}{\phi\left(2\theta^2\alpha^4 + 2\theta^2\alpha^2 kz + 5z^2\theta\alpha^2 + 3\theta\alpha^2\phi z + 2\theta\phi kz^2 + 2\theta kz^3 + 2z^4 + 2\phi z^3\right)}, \tag{A7}$$

where $\phi = \sqrt{(z^2 + 2\theta\alpha^2)} = \psi(\alpha^*, \gamma^*)$.

The expression $\partial n^*/\partial \theta$ is greater than zero for $z \geq r\sigma^2 k = \theta k$, which follows from our assumptions that $z \geq 1$ and $1/k \geq r\sigma^2$.

Now we turn to firm value. To sign these derivatives, we establish one additional fact:

$$\frac{\partial \alpha}{\partial z} = \frac{2\theta k\alpha\left(z^2 + \phi z + \theta\alpha^2\right)}{2z^4 + 2\theta kz^3 + 2z^3\phi + 5z^2\alpha^2\theta + 2z^2\theta k\phi + 3z\phi\alpha^2\theta + 2\theta^2\alpha^2 kz + 2\theta^2\alpha^4}. \tag{A8}$$

This is less than one because $\alpha < 1$ and $z \geq 1$.

Expected firm value varies with the exogenous parameters in the following way:

$$\frac{\partial E(\pi)}{\partial r} = \frac{1}{k}\frac{\partial \alpha}{\partial r} - \frac{\partial n^*}{\partial r} < 0$$
$$\frac{\partial E(\pi)}{\partial \sigma^2} = \frac{1}{k}\frac{\partial \alpha}{\partial \sigma^2} - \frac{\partial n^*}{\partial \sigma^2} < 0. \tag{A9}$$

[27] Here and in what follows we abuse notation and write $\alpha$ in place of $\alpha^*$ to simplify the expressions. All subsequent $\alpha$'s in Appendix A should be interpreted as equilibrium $\alpha^*$'s.

These follow immediately because $\partial\alpha/\partial r < 0$, $\partial n^*/\partial r > 0$, $\partial\alpha/\partial\sigma^2 < 0$, and $\partial n^*/\partial\sigma^2 > 0$.

$$\begin{aligned}\frac{\partial E(\pi)}{\partial k} &= \frac{1}{k}\frac{\partial\alpha}{\partial k} - \frac{\alpha}{k^2} - \frac{\theta\alpha}{\phi}\frac{\partial\alpha}{\partial k} \\ &< \frac{1}{k}\frac{\partial\alpha}{\partial k} - \frac{\theta\alpha}{\phi}\frac{\partial\alpha}{\partial k} = \frac{1}{k}\left(1 - \frac{\theta k\alpha}{\phi}\right)\frac{\partial\alpha}{\partial k} \\ &< \frac{1}{k}\left(1 - \frac{z}{\phi}\right)\frac{\partial\alpha}{\partial k} < 0. \end{aligned} \tag{A10}$$

This follows because $z \geq r\sigma^2 k = \theta k$, $\alpha < 1$, and $\partial\alpha/\partial k < 0$.

$$\begin{aligned}\frac{\partial E(\pi)}{\partial z} &= \frac{1}{k}\frac{\partial\alpha}{\partial z} - \frac{1}{2} - \frac{1}{4}\frac{2z + 4\theta\alpha\frac{\partial\alpha}{\partial z}}{\phi} < \frac{1}{k}\frac{\partial\alpha}{\partial z} - \frac{1}{2} - \frac{1}{2}\frac{z\frac{\partial\alpha}{\partial z} + 2\theta\alpha\frac{\partial\alpha}{\partial z}}{\phi} \\ &= \left(\frac{1}{k} - \frac{1}{2}\frac{z + 2\theta\alpha}{\phi}\right)\frac{\partial\alpha}{\partial z} - \frac{1}{2} < \left(\frac{1}{k} - \frac{1}{2}\right)\frac{\partial\alpha}{\partial z} - \frac{1}{2} < 0. \end{aligned} \tag{A11}$$

This follows because $k \geq 1$ and $0 < \partial\alpha/\partial z < 1$.

## Appendix B

In this Appendix, we show that our main results are robust to different assumptions about the contractibility of diversification and the sources of benefits from diversification. Table B1 shows the comparative static results assuming that the level of diversification $n$ is not contractible. Within this table, we consider three cases: the manager has private benefits only, the manager has risk reduction benefits only, and the manager has both private benefits and risk reduction benefits. In each case, we provide the manager's certainty equivalent to facilitate comparisons across combinations of assumptions.

Table B2 shows the comparative static results assuming that the level of diversification $n$ is contractible, as in the model in the text. Within this table, we also consider three cases: the manager has private benefits only, the manager has risk reduction benefits only, and the manager has both private benefits and risk reduction benefits. This last case is the case considered in the text.

Across cases, the most important comparative statics are those for

$$\left.\frac{\partial n*}{\partial\alpha*}\right|_{\partial i} \quad \text{and} \quad \left.\frac{\partial E(\pi)}{\partial\alpha*}\right|_{\partial i}$$

for $i \in \{r, \sigma^2, k, z\}$. In general, $\partial n^*/\partial\alpha^*$ is negative if the source of variation is the risk variables, $r$ and $\sigma^2$, and $\partial n^*/\partial\alpha^*$ is positive if the source of variation is private benefits $z$. The expression $\partial n^*/\partial\alpha^*$ can be either positive or negative depending upon the assumptions if the source of variation is the disutility of the action $k$. In general, $[\partial E(\pi)]/\partial\alpha^*$ is positive if the source of variation is the risk variables, $r$ and $\sigma^2$, or the disutility of the action $k$. The expression $[\partial E(\pi)]/\partial\alpha^*$ is negative if the source of variation is private benefits $z$. Thus, the main comparative statics that we test are robust to different combinations of assumptions.

**Table B1**
## Diversification Not Contractible

Case 1. Private Benefits Only. Manager's utility is $\boldsymbol{u} = \boldsymbol{w}_0 + \boldsymbol{\alpha}\,(\boldsymbol{x} - \boldsymbol{n}) - (\boldsymbol{k}/2)\boldsymbol{x}^2 + \boldsymbol{z}\ln \boldsymbol{n} - (\boldsymbol{r}/2)\boldsymbol{\alpha}^2\boldsymbol{\sigma}^2$.

| | | | | | |
|---|---|---|---|---|---|
| $\frac{\partial \alpha *}{\partial r} < 0$ | $\frac{\partial n *}{\partial r} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial r} < 0$ | $\frac{\partial E(\pi)}{\partial r} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial r} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial r} < 0$ |
| $\frac{\partial \alpha *}{\partial \sigma^2} < 0$ | $\frac{\partial n *}{\partial \sigma^2} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial \sigma^2} < 0$ | $\frac{\partial E(\pi)}{\partial \sigma^2} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial \sigma^2} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial \sigma^2} < 0$ |
| $\frac{\partial \alpha *}{\partial k} < 0$ | $\frac{\partial n *}{\partial k} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial k} < 0$ | $\frac{\partial E(\pi)}{\partial k} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial k} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial k} < 0$ |
| $\frac{\partial \alpha *}{\partial z} > 0$ | $\frac{\partial n *}{\partial z} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial z} > 0$ | $\frac{\partial E(\pi)}{\partial z} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial z} < 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial z} < 0$ |

Case 2. Risk Reduction Only. Manager's utility is $\boldsymbol{u} = \boldsymbol{w}_0 + \boldsymbol{\alpha}\,(\boldsymbol{x} - \boldsymbol{n}) - (\boldsymbol{k}/2)\boldsymbol{x}^2 - (\boldsymbol{r}/2)\boldsymbol{\alpha}^2(\boldsymbol{\sigma}^2/\boldsymbol{n})$.
Cannot guarantee existence of an incentive contract on (0,1).

Case 3. Both. Manager's utility is $\boldsymbol{u} = \boldsymbol{w}_0 + \boldsymbol{\alpha}\,(\boldsymbol{x} - \boldsymbol{n}) - (\boldsymbol{k}/2)\boldsymbol{x}^2 + \boldsymbol{z}\ln \boldsymbol{n} - (\boldsymbol{r}/2)\boldsymbol{\alpha}^2(\boldsymbol{\sigma}^2/\boldsymbol{n})$.

| | | | | | |
|---|---|---|---|---|---|
| $\frac{\partial \alpha *}{\partial r} < 0$ | $\frac{\partial n *}{\partial r} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial r} < 0$ | $\frac{\partial E(\pi)}{\partial r} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial r} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial r} < 0$ |
| $\frac{\partial \alpha *}{\partial \sigma^2} < 0$ | $\frac{\partial n *}{\partial \sigma^2} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial \sigma^2} < 0$ | $\frac{\partial E(\pi)}{\partial \sigma^2} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial \sigma^2} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial \sigma^2} < 0$ |
| $\frac{\partial \alpha *}{\partial k} < 0$ | $\frac{\partial n *}{\partial k} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial k} < 0$ | $\frac{\partial E(\pi)}{\partial k} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial k} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial k} < 0$ |
| $\frac{\partial \alpha *}{\partial z} > 0$ | $\frac{\partial n *}{\partial z} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial z} > 0$ | $\frac{\partial E(\pi)}{\partial z} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial z} < 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial z} < 0$ |

**Table B2**
## Diversification Contractible

Case 4. Private Benefits Only. Manager's utility is $\boldsymbol{u} = \boldsymbol{w}_0 + \boldsymbol{\alpha}(\boldsymbol{x} - \boldsymbol{n}) + \gamma \boldsymbol{n} - (\boldsymbol{k}/2)\boldsymbol{x}^2 + \boldsymbol{z}\ln \boldsymbol{n} - (\boldsymbol{r}/2)\boldsymbol{\alpha}^2\boldsymbol{\sigma}^2$.

| | | | | | |
|---|---|---|---|---|---|
| $\frac{\partial \alpha *}{\partial r} < 0$ | $\frac{\partial n *}{\partial r} = 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial r} = 0$ | $\frac{\partial E(\pi)}{\partial r} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial r} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial r} = -\infty$ |
| $\frac{\partial \alpha *}{\partial \sigma^2} < 0$ | $\frac{\partial n *}{\partial \sigma^2} = 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial \sigma^2} = 0$ | $\frac{\partial E(\pi)}{\partial \sigma^2} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial \sigma^2} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial \sigma^2} = -\infty$ |
| $\frac{\partial \alpha *}{\partial k} < 0$ | $\frac{\partial n *}{\partial k} = 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial k} = 0$ | $\frac{\partial E(\pi)}{\partial k} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial k} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial k} = -\infty$ |
| $\frac{\partial \alpha *}{\partial z} = 0$ | $\frac{\partial n *}{\partial z} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial z} = \infty$ | $\frac{\partial E(\pi)}{\partial z} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial z} = -\infty$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial z} < 0$ |

Case 5. Risk Reduction Only. Manager's utility is $\boldsymbol{u} = \boldsymbol{w}_0 + \boldsymbol{\alpha}(\boldsymbol{x} - \boldsymbol{n}) + \gamma \boldsymbol{n} - (\boldsymbol{k}/2)\boldsymbol{x}^2 - (\boldsymbol{r}/2)\boldsymbol{\alpha}^2\,(\boldsymbol{\sigma}^2/\boldsymbol{n})$.

| | | | | | |
|---|---|---|---|---|---|
| $\frac{\partial \alpha *}{\partial r} < 0$ | $\frac{\partial n *}{\partial r} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial r} < 0$ | $\frac{\partial E(\pi)}{\partial r} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial r} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial r} < 0$ |
| $\frac{\partial \alpha *}{\partial \sigma^2} < 0$ | $\frac{\partial n *}{\partial \sigma^2} > 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial \sigma^2} < 0$ | $\frac{\partial E(\pi)}{\partial \sigma^2} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial \sigma^2} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial \sigma^2} < 0$ |
| $\frac{\partial \alpha *}{\partial k} < 0$ | $\frac{\partial n *}{\partial k} < 0$ | $\left.\frac{\partial n *}{\partial \alpha *}\right\|_{\partial k} > 0$ | $\frac{\partial E(\pi)}{\partial k} < 0$ | $\left.\frac{\partial E(\pi)}{\partial \alpha}\right\|_{\partial k} > 0$ | $\left.\frac{\partial E(\pi)}{\partial n}\right\|_{\partial k} > 0$ |

**Table B2**—*continued*

Case 6. Both. Manager's utility is $\boldsymbol{u} = \boldsymbol{w}_0+\boldsymbol{\alpha}(\boldsymbol{x}-\boldsymbol{n})+\gamma\boldsymbol{n}-(\boldsymbol{k}/2)\boldsymbol{x}^2+\boldsymbol{z}\ln\boldsymbol{n}-(\boldsymbol{r}/2)\boldsymbol{\alpha}^2(\boldsymbol{\sigma}^2/\boldsymbol{n})$.

| | | | | | |
|---|---|---|---|---|---|
| $\frac{\partial\alpha*}{\partial r}<0$ | $\frac{\partial n*}{\partial r}>0$ | $\frac{\partial n*}{\partial\alpha*}\Big\|_{\partial r}<0$ | $\frac{\partial E(\pi)}{\partial r}<0$ | $\frac{\partial E(\pi)}{\partial\alpha}\Big\|_{\partial r}>0$ | $\frac{\partial E(\pi)}{\partial n}\Big\|_{\partial r}<0$ |
| $\frac{\partial\alpha*}{\partial\sigma^2}<0$ | $\frac{\partial n*}{\partial\sigma^2}>0$ | $\frac{\partial n*}{\partial\alpha*}\Big\|_{\partial\sigma^2}<0$ | $\frac{\partial E(\pi)}{\partial\sigma^2}<0$ | $\frac{\partial E(\pi)}{\partial\alpha}\Big\|_{\partial\sigma^2}>0$ | $\frac{\partial E(\pi)}{\partial n}\Big\|_{\partial\sigma^2}<0$ |
| $\frac{\partial\alpha*}{\partial k}<0$ | $\frac{\partial n*}{\partial k}<0$ | $\frac{\partial n*}{\partial\alpha*}\Big\|_{\partial k}>0$ | $\frac{\partial E(\pi)}{\partial k}<0$ | $\frac{\partial E(\pi)}{\partial\alpha}\Big\|_{\partial k}>0$ | $\frac{\partial E(\pi)}{\partial n}\Big\|_{\partial k}>0$ |
| $\frac{\partial\alpha*}{\partial z}>0$ | $\frac{\partial n*}{\partial z}>0$ | $\frac{\partial n*}{\partial\alpha*}\Big\|_{\partial z}>0$ | $\frac{\partial E(\pi)}{\partial z}<0$ | $\frac{\partial E(\pi)}{\partial\alpha}\Big\|_{\partial z}<0$ | $\frac{\partial E(\pi)}{\partial n}\Big\|_{\partial z}<0$ |

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