Current version: July 15, 2007

Are Internal Capital Markets Good for Innovation?

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Abstract: Which type of firm is more innovative: the decentralized, diversified corporation or the smaller, more narrowly focused "entrepreneurial" firm? According to one argument, diversified corporations can do more R&D because their operating units have access to an internal capital market. Other writers argue that decentralized, diversified firms over-rely on financial accounting criteria to evaluate the performance of their operating units, discouraging divisional managers from investing in projects like R&D with long-term, uncertain payoffs. This paper uses a comprehensive sample of diversified and nondiversified firms from 1980 to 1999 to study the relationship between diversification and innovation. I find a robust negative correlation between diversification and R&D intensity, even when controlling for firm scale, cash flow, and investment opportunities. Industry-adjusted R&D—the difference between the R&D intensity of a diversified firm and the R&D intensity it would most likely have if its divisions were standalone firms—is negative, consistent with the hypothesis that diversification reduces innovation by discouraging R&D investment. However, other evidence suggests that internal-capital-market inefficiencies, rather than managerial myopia, are driving the negative relationship between diversification and innovation.

JEL: O32, D23, G34

I am grateful to Douglas Allen, Chris Anderson, Nick Argyres, Dennis Beresford, Philip Curry, Bronwyn Hall, Guy Holborn, John Howe, Julia Liebeskind, Lasse Lien, Jeff Netter, and participants at the Allied Social Sciences Association, the International Society for New Institutional Economics, Baylor University, Copenhagen Business School, George Mason University, University of Illinois, University of Kansas, University of Missouri, National Technical University of Athens (Greece), Simon Fraser University, and Washington University, St. Louis for helpful comments. Won Joong Kim and Kathrin Zoeller provided valuable research assistance.

1. Introduction

Which type of firm is more innovative: the decentralized, diversified corporation or the smaller, more narrowly focused "entrepreneurial" firm? According to one argument, diversified corporations can do more R&D because their operating units have access to an internal capital market. As developed by Alchian (1969), Williamson (1975), Gertner, Scharfstein, and Stein (1994), and Stein (1997), this theory holds that internal capital markets have advantages where access to external funds is limited. In particular, the central office of the diversified firm can use informational advantages, residual control rights, and its ability to intervene selectively to allocate resources within the firm better than the external capital markets would do if the divisions were standalone firms. These advantages could be particularly important for investments in R&D, where the information asymmetry between the firm and outside investors is likely to be greatest (Myers and Majluf, 1984; Stein, 1988). Indeed, economists have argued, at least since Schumpeter (1942), that firms' R&D expenditures are constrained by the availability of internal finance (Kamien and Schwartz, 1978; Himmelberg and Petersen, 1994; Brown, 1997).[1] Because the subsidiaries of a diversified firm have access to the cash flows of other subsidiaries within the firm, as well as their own cash flows, they have potential access to more generous sources of internal finance.

By contrast, the strategic-management literature has generally argued that unrelated diversification is harmful to innovation. Hoskisson and Hitt (1988, 1994), Hitt, Hoskisson, and Ireland (1990), Hoskisson, Hitt, and Hill (1993), and others argue that decentralized, widely diversified firms over-rely on financial accounting criteria to evaluate the performance of their operating units. Because these firms are widely diversified, it is claimed, central managers do not have the expertise to evaluate the long-term potential of R&D investments by divisional managers. As a

[1] Hall (1999, p. 5) notes that "[e]very senior executive I have interviewed in the past several years has confirmed that they view external finance in general, and debt finance in particular, as inappropriate for funding R&D investment." Early-stage venture finance, she notes, is an exception.

result, the central office must use internal rate-of-return measures to assess divisional performance, and this discourages divisional managers from investing in projects like R&D with long-term, uncertain payoffs. Consequently, large, diversified enterprises suffer from a form of managerial myopia; they make relatively smaller investments in R&D and over time perform worse than smaller, more centralized firms.

An influential *Harvard Business Review* survey in 1980 blamed managerial myopia for the poor performance of U.S. firms in the 1970s. "By their preference for servicing existing markets rather than creating new ones and by their devotion to short-term returns and 'management by the numbers,' many [U.S. managers] have effectively forsworn long-term technological superiority as a competitive weapon" (Hayes and Abernathy, 1980, p. 70). Chandler (1990, p. 8) expresses a similar sentiment in his assessment of the conglomerate merger wave: "More serious to the long-term health of American companies and industries was the diversification movement of the 1960s—and the chain of events it helped to set off. When senior managers chose to grow through diversification—to acquire businesses in which they had few if any organizational capabilities to give them a competitive edge—they ignored the logic of managerial enterprise."

A negative relationship between diversification and R&D could also help explain the dramatic increase in private-sector R&D expenditures said to characterize the "new economy" (National Science Board, 2000). Existing explanations for this trend emphasize changes in the organization of R&D, from a vertically integrated process based on proprietary standards to a more decentralized, more modular process relying on collaboration and open standards (Matcher, Mowery, and Hodges, 1999; Cockburn, Henderson, Orsenigo, and Pisano, 1999; Baldwin and Clark, 2000). Other studies focus on the increased importance of basic research for new product development in information technology and biotechnology (Cohen and Levinthal, 1989; Cockburn, Henderson, and Stern, 1999). If diversification reduces R&D, then the corporate refocusing movement of the 1980s and 1990s could also have contributed to the increase in private-sector R&D.

This paper assesses these claims by examining a comprehensive sample of diversified and nondiversified firms over a twenty-year period from 1980 to 1999, a period marked by both an increase in corporate focus and an increase in private sector R&D intensity. The sample includes the basic universe of U.S. nonfinancial corporations for which data are available on business activities by industry segment. I find a strong, robust negative relationship between diversification and R&D intensity, suggesting that diversification is associated with reduced levels of innovative activity. However, some findings appear inconsistent with the managerial myopia hypothesis, which posits a reluctance on the part of divisional managers to invest in R&D. Instead, the data appear more consistent with the view that the internal capital market itself fails to provide adequate resources for the divisional managers to pursue a strategy of investing in innovation.

The analysis consists of three parts. I begin by showing that R&D intensity is generally decreasing with the level of diversification, throughout the sample period. The negative relationship between diversification and R&D is fairly stable over time and robust to the measure of diversification used. Moreover, this relationship generally holds even when differences in scale, cash flow, and investment opportunities are taken into account. These controls are particularly important because both R&D and diversification could be driven by other firm- or industry-specific characteristics, both observable and unobservable. For instance, factors causing firms to underinvest in R&D could also cause them to diversify, resulting in an observed negative relationship between R&D and diversification even if there is no causal relationship between the two. By controlling for firm size, income, and investment opportunities, I can hold these observable firm- and industry-specific characteristics constant while examining the relationship between R&D and diversification. I also use a fixed-effects estimator to control for unobservable firm-specific factors that might drive the decision to invest in innovation. In all cases, the negative relationship between R&D and diversification remains statistically and economically significant.

Second, I use techniques developed in the "diversification-discount" literature in empirical corporate finance to construct measures of industry-adjusted R&D for diversified firms. Following Lang and Stulz (1994), Berger and Ofek (1995), Servaes (1996), Rajan, Servaes, and Zingales (2000), and others, I compute the difference between the R&D expenditures of a diversified firm and the R&D expenditures of a pure-play portfolio of single-segment firms in the same industries as the diversified firm's divisions. This provides a measure of industry-adjusted R&D or pure-play innovation. Existing studies of diversification and innovation (Hoskisson and Hitt, 1988; Hitt, Hoskisson, and Ireland, 1990; Cardinal and Opler, 1995; Rogers, 1999) compare groups of diversified firms to control groups of nondiversified firms, without controlling for the diversified firm's specific activities. However, if the subsidiaries of a diversified firm are systematically different from firms in the control group—operating in different industries with different growth opportunities, or at a less efficient scale, for example—then such a comparison would lead to the conclusion that diversification reduces innovation, even if the negative relation between diversification and innovation has nothing to do with diversification itself.

To address this problem, I compare measures of innovation by diversified firms with the hypothetical levels of innovation those firms would have if each of their divisions was as innovative as the average nondiversified firm in the division's industry. This comparison assesses the effects of diversification on innovation independent of the effects of diversification per se. If diversification increases innovation, then the industry-adjusted R&D level of a diversified firm—the difference between its R&D intensity and the R&D intensity of a pure-play matching portfolio—should be positive. If industry-adjusted R&D is negative, then that firm would presumably be more innovative if its subsidiaries were standalone firms.

The results from these calculations are consistent with the hypothesis that diversification reduces innovation by discouraging R&D investment, at least for some years. Specifically, I find an "R&D discount" ranging from −0.006 in 1980 to −0.013 in 1999. That is, in 1999 the R&D intensity of the average diversified firm was 1.3 percentage points lower than the R&D intensity

of a size- and industry-matched portfolio of nondiversified firms. (The discount does not systematically vary with the level of diversification, however.) Like the previous results, this finding is consistent with the claim that diversified firms provide insufficient incentives for divisional managers to invest in R&D, despite the availability of funds from the internal capital market. And because the portfolio-matching technique controls for industry and size, the negative relationship between R&D and diversification cannot be explained in terms of differences in industry-specific differences in the innovation opportunity set. To further confirm the result, I regress industry-adjusted R&D on firm size, cash flow, and investment opportunities and find that the R&D discount is increasing in the degree of diversification. This result remains even while controlling for unobservable firm-specific characteristics in a fixed-effects model, which mitigates the potential endogeneity between and firm's R&D intensity and its decision to diversify.

The above results are consistent with the myopia hypothesis. However, they are also consistent with the claim that the internal capital market itself fails to provide adequate funds for divisional innovation, independent of the incentives facing divisional managers. To distinguish between these two explanations, I use segment-level data on R&D and cash flow to examine the effects of internal-capital-market affiliation on the business unit's commitment to innovation. The results here do not strongly support the myopia hypothesis. There is some evidence for R&D underinvestment at the smallest segments of diversified firms, but no evidence for underinvestment at the largest segments. Managerial myopia is more likely at large segments, while reliance on the internal capital market to fund innovation is more likely at small segments. This suggests that internal-capital-market inefficiencies, rather than managerial myopia, may be driving the negative relationship between diversification and innovation.

The remainder of the paper is organized as follows. Section 2 reviews the hypotheses motivating the analysis along with the segment-level data provided by Compustat. Preliminary comparisons of R&D intensity among different types of firms are presented in Section 3. Section 4 gives the results of the portfolio-simulation technique for estimating industry-adjusted R&D for

multiple-segment firms. Section 5 presents an analysis of segment-level R&D and cash flow data. Conclusions and directions for future research are given in Section 6.

2. Hypotheses and data

Several papers in financial economics examine incentives of managers to engage in R&D.[2] Often, R&D itself is not the main variable of interest in these studies. Rather, R&D is used as an example of an investment with long-term, uncertain returns. If managers are myopic, sacrificing potential long-term earnings and growth opportunities for short-term profits, they will tend to avoid investments like R&D. While good for managers in the short term, this tendency can hurt the long-term performance of the firm. In Stein's (1988) model, the existence of an active takeover market exacerbates managerial myopia, so firms facing a takeover threat will reduce long-term investments like R&D. He suggests that firms that can construct barriers to takeover ("shark repellants") will reduce myopia. However, Hall (1988, 1999) finds that mergers did not generally reduce R&D.[3] Moreover, Meulbroek et al. (1990) find that firms do not increase their R&D expenditures after constructing a shark repellant, as Stein's model predicts. Other studies have found that antitakeover amendments generally seem to protect incumbent management rather than reduce myopia.[4]

Hoskisson and Hitt (1988, 1994), Hitt, Hoskisson, and Ireland (1990), and Hoskisson, Hitt, and Hill (1993) argue that myopia is a larger problem for divisional managers in a diversified firm. Such firms, they claim, rely on financial rather than "strategic" controls to evaluate divisional performance. Strategic controls evaluate divisional managers based on their contributions—often subjectively defined—to an overall strategic plan (Goold and Campbell, 1987). In-

[2] This literature focuses on agency conflicts within the firm, assuming that managers will not always take actions that maximize the value of the firm. A related literature in industrial organization (surveyed by Cohen and Levin, 1991) asks how market structure, patent policy, and other factors affect the levels of R&D that do maximize firm value.

[3] Hall (1980) finds no effect of mergers on post-merger R&D at U.S. publicly traded corporations during the 1980s; Hall (1999) finds a small, negative effect, but it is not statistically significant.

[4] See DeAngelo and Rice (1983) and Jarrell and Poulsen (1987).

formation is exchanged between divisional and senior managers through both formal and informal interaction, and senior managers need substantial information about divisional activities and profit opportunities. Financial controls, by contrast, evaluate divisional performance based on objective performance criteria such as return-on-investment ratios. Divisions are treated as independent business units whose performance is rated relative to corporate-level financial targets. Unlike strategic controls, financial controls can be applied without detailed knowledge of individual business-unit activities. Because strategic controls are feasible only within more centralized structures, highly diversified corporations will tend to rely on financial controls.[5]

The use of financial controls offers potential advantages, however. In particular, this mode of organization releases the central office from responsibility for day-to-day business-unit activities, freeing central managers to focus on long-term strategic goals (such as acquisitions and overall corporate structure) (Williamson, 1975). Hoskisson and Hitt (1988, 1994) and Hoskisson, Hitt, and Hill (1993) argue, however, that reliance on financial controls discourages divisional managers from investing in long-term, uncertain projects such as R&D. Hoskisson and Hitt (1988) find that diversified U.S. multidivisional or "M-form" firms in the 1970s had lower R&D intensities than less diversified, unitary or "U-form" firms. Rogers (1999) examine a sample of large Australian firms from the 1990s and find that more focused firms tend to have higher R&D intensities, though Cardinal and Opler (1995) find no statistically discernible effect of diversification on innovative efficiency in U.S. firms during the 1980s.[6]

If diversification encourages myopia by divisional managers, then diversified firms will have lower R&D intensities, controlling for other characteristics that affect the firm's propensity to

[5] As Baysinger and Hoskisson (1989, p. 313) point out, the choice of control system is continuous, not discrete, as firms may choose a mix of financial and strategic controls. A single-business firm will tend to rely exclusively on strategic controls; a "related-diversified" firm will use both financial and strategic controls; an "unrelated-diversified" firm will generally eschew strategic controls altogether. In the present context, this implies that the degree to which the firm relies on financial controls is an increasing function of the level of diversification. Of course, it is impossible to observe the sample firms' control systems directly.

[6] Barringer and Bluedorn (1999) develop a composite index of "corporate entrepreneurship," comprising measures of innovative intensity, risk taking, and other strategic decisions, and show that corporate entrepreneurship is negatively correlated with the use of financial controls.

invest in innovation. R&D underinvestment should be visible at the level of the firm, as well as the level of the individual division. On the other hand, particular divisions of a diversified firm may underinvest in R&D not because the divisional managers are reluctant to pursue long-term projects, but rather because the division is unable to obtain the necessary funding from corporate headquarters—i.e., because the internal capital market performs poorly relative to external capital markets.

Evidence on the value of internal capital markets is mixed, despite a growing literature in empirical corporate finance. Early studies by Lang and Stulz (1994), Berger and Ofek (1995), Servaes (1996), and Rajan, Servaes, and Zingales (2000) found that diversified firms were valued at a discount relative to more specialized firms in the 1980s and early 1990s. Lang and Stulz (1994), for example, find an average industry-adjusted discount—the difference between a diversified firm's q and its pure-play q—ranging from −0.35 for two-segment firms to −0.49 for five-or-more-segment firms. Bhagat, Shleifer, and Vishny (1990) and Comment and Jarrell (1995) document positive stock-price reactions to refocusing announcements.[7] The apparent poor relative performance of internal capital markets has been explained in terms of rent seeking by divisional managers (Scharfstein and Stein, 2000), bargaining problems within the firm (Rajan, Servaes, and Zingales, 1997) or bureaucratic rigidity (Shin and Stulz, 1998). For these reasons, it is argued, corporate managers fail to allocate investment resources to their highest-valued uses, both in the short and long term.

On the other hand, as pointed out by Campa and Kedia (2002), Graham, Lemmon, and Wolf (2002), Chevalier (2004), and Villalonga (2004), diversified firms may trade at a discount not because diversification destroys value, but because undervalued firms tend to diversify. Diversification is endogenous and the same factors that cause firms to be undervalued may also cause them to diversify. Campa and Kedia (2002), for example, show that correcting for selection bias

[7] Matsusaka (1993), Hubbard and Palia (1999), and Klein (2001) argue, by contrast, that diversification may have created value during the 1960s and early 1970s by creating efficient internal capital markets.

using panel data and fixed effects and two-stage selection models substantially reduces the observed discount (and can even turn it into a premium).[8]

This strand of research suggests an alternate explanation for R&D underinvestment at diversified firms. Even if divisional managers are not mypoic, they may be unable to engage in R&D because the internal capital market does not make sufficient funds available. If the internal capital market is highly inefficient, financing R&D with funds generated from other divisions could be even more difficult than financing R&D with external finance. For this reason, divisions of diversified firms could do less R&D than standalone firms with similar characteristics, even absent myopia by divisional managers. Section 5 uses segment-level data on R&D and cash flow to cast light on these competing explanations for R&D underinvestment.

Line-of-business data for U.S. corporations have been available since the late 1970s,[9] and Compustat provides these data in its business industry segments file.[10] I retrieve firm- and segment-level data on R&D, sales, assets, cash flow, and *q* for the years 1980 to 1999. I use the active and research files of Compustat, so the sample includes firms that were subsequently delisted due to acquisition, bankruptcy, or liquidation. I exclude segments in finance (SIC 6000–6999) and regulated utilities (SIC 4900 and 4999). To keep the dataset manageable I also exclude segments with less than $1 million in annual sales (the Compustat segment file already excludes segments contributing less than 10 percent of the firm's annual sales).

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[8] There are also important data and measurement problems. Most studies use Tobin's *q* to measure divisional investment opportunities, but it is marginal *q*—which may not be closely correlated with observable *q*—that drives investment (Whited, 2001). SIC codes are also typically used to measure diversification and to identify industries, but the SIC system contains significant errors (Kahle and Walkling, 1996) and cannot reliably distinguish between related and unrelated activities (Teece, Dosi, Rumelt, and Winter, 1994; Klein and Lien, 2005).

[9] FASB-SFAS No. 14 and SEC Regulation S-K require that firms report information on their business segments for fiscal years ending after December 15, 1977. The Compustat business industry files provide data on sales, operating income, depreciation, capital expenditures, assets, employees, and R&D by industry segment. The segments are identified by 4-digit SIC codes. FASB-SFAS No. 131, released in 1997, amends No. 14 to require that firms report information on "operating segments," defined according to how the firm's businesses are managed. The amendment was issued partly in response to complaints that too many firms were reporting themselves to be in a single "industry."

[10] Holthausen, Larcker, and Sloan (1994), Shin and Stulz (1998), Wulf (1998), and Campa and Kedia (2002) also use the Compustat business industry segment files.

Descriptive statistics are provided in Table 1. The changes in R&D intensity (the ratio of R&D to total assets) and diversification over time suggest a negative relationship between diversification and innovation. Average R&D intensity for the sample firms went from 3.94 percent in 1980 to 6.78 percent in 1985, 7.75 percent in 1990, 10.24 percent in 1995, and 10.93 percent in 1999. At the same time, the level of diversification was generally decreasing. The average number of industry segments for the sample firms fell from 2.19 in 1980 to 1.86 in 1985, 1.69 in 1990, and 1.48 in 1995, reflecting the corporate refocusing movement of the 1980s and early 1990s. The average number of industry segments rose in 1999, however, to 1.98, presumably in response to a FASB rule change enacted in 1997 and requiring more precise definitions of segments.[11]

[Table 1 about here]

Admittedly, the number of industry segments is a crude measure of diversification. Another frequently used measure is a Herfindahl index weighted by segment sales or segment assets. Table 1 also provides the mean and median values for segment sales–weighted Herfindahl indexes for each of the sample firms. The Herfindahl is computed as the sum of squared segment sales divided by the square of total firm sales. A single-segment firm will have a Herfindahl of 100 percent, while a firm with four equally sized segments will have a Herfindahl of 25 percent. The Herfindahls provide a better measure of diversification than the number of industry segments. For instance, a firm with four evenly weighted segments is more diversified than a firm with one large segment and three small segments, though both have four industry segments.

Table 1 shows that the average segment sales–weighted Herfindahl has generally been rising over time, indicating a decrease in the average level of diversification. (Again, there is a slight increase in average diversification between 1995 and 1999.) This pattern is consistent with that observed using the simpler measure of diversification, the number of industry segments.

[11] See footnote 9 above.

3. Basic results

Using the sample described above, I first compute average and median values of R&D intensity for firms with one, two, three, four, five, and six or more segments. Table 2 reports these computations. The results are consistent with managerial myopia: mean and median R&D intensities are highest for single-segment firms and generally (though not monotonically) declining in the number of industry segments. This pattern is roughly consistent throughout the five cross-sections, even while average R&D intensity for all firms in a given year is increasing throughout the sample period.

[Table 2 about here]

As mentioned above, factors other than corporate refocusing—open standards, modularity, and science-based discovery, for instance—have been identified as possible sources of increased R&D expenditures over time. Table 2 suggests that these practices have been used disproportionately by nondiversified firms. Among single-segment firms, for example, average R&D intensity rose gradually from 4.4 percent in 1980 to 6.6 percent in 1985, 7.7 percent in 1990, and 9.7 percent in 1995. (The 1999 results must be interpreted with caution, given the change in the definition of industry segments described previously.) Among two-segment firms, by contrast, average R&D intensity rose slightly between 1980 and 1985 (from 3.4 percent to 4.2 percent) but remained roughly constant afterward (through 1995). The same is true for firms with three, four, five, and six or more segments. For some types of firm, R&D intensity actually declined slightly over the sample period. This suggests that the drivers of increased R&D most often mentioned in the literature on innovation apply only to focused firms.

I next repeat the exercise, this time using the segment sales–weighted Herfindahl index (H) as the measure of diversification. Table 3 reports the results. Following Lang and Stulz (1994), I divide the firms in each year into five categories: $H = 1$ (single-segment firms), $0.8 \leq H < 1$, $0.6 \leq H < 0.8$, $0.4 \leq H < 0.6$, and $H < 0.4$. The results are similar to, but weaker than, the results pre-

sented in Table 2. Single-segment firms have the highest R&D intensities and the most diversified firms have the lowest R&D intensities, though the pattern is somewhat muddled in-between. Multiple-segment firms with one or more large segments and several smaller segments ($0.8 \leq H < 1$) generally have lower R&D intensities than multiple-segment firms with several similarly sized segments ($0.6 \leq H < 0.8$). Still, these data are consistent with the view that diversification reduces innovation by rewarding myopic behavior on the part of divisional managers.

[Table 3 about here]

These simple comparisons, while suggestive, do not control for the possibility that firms with different numbers or distributions of segments differ in other ways, such as size, age, overall firm cash flow, and investment opportunities. Moreover, these comparisons do not account for the endogeneity of the diversification decision itself. As shown by Campa and Kedia (2002), Villalonga (2004), and others, firms that diversify are different from firms that remain focused. The same factors that cause firms to diversify could also cause them to underinvest in R&D, leading to a (spurious) observed negative correlation between R&D and diversification.

To obtain a more precise measure of the effects of diversification on R&D, I run a series of panel regressions of R&D investment on a diversification measure, a constant, and three control variables, firm size, cash flow margin, and q. Firm size is measured as the natural logarithm of net sales. Diversified firms are usually larger than nondiversified firms, so the size control is important. Cash flow margin is measured as income available for the common plus depreciation less income taxes paid, plus R&D, all divided by net sales. R&D is added to the numerator because firms treat R&D as an expense (see also Himmelberg and Petersen, 1994). I follow Smith and Watts (1992) in computing q as the value of common and preferred stock plus total assets minus shareholder's equity, all divided by total assets. As is common in investment–cash-flow regressions, I include q to control for differences in investment opportunities. The dependent variable, R&D, is scaled by total assets. Due to the change in the definition of an industry segment for years beginning in 1998, I use only the 1980–97 section of the sample.

Table 4 reports the results of these regressions. I use simple OLS, a model with firm-fixed effects (to explore the effects of within-firm variation in the independent variables), and a model with firm-specific random effects (variance components). All the models include year-fixed effects, which proxy for changes in the cost of capital over time. Diversification is measured as $1-H$ where H is the Herfindahl index of diversification, as defined above. The coefficient on this variable is negative and highly significant in all three specifications. The coefficient on cash flow margin is positive and highly significant, documenting the importance of internal finance for R&D.

[Table 4 about here]

As in Campa and Kedia (2002), the coefficient on the diversification index is smallest (in absolute value) in the model with firm-fixed effects. This suggests that unobservable firm-specific characteristics explain part of the "R&D discount": the characteristics that cause firms to diversify may also cause them to underinvest in R&D. However, because the within-firm relationship between diversification and innovation is still negative and significant, unobserved heterogeneity is not likely to be the primary driver of the results.

Moreover, the fixed-effects specification helps control for unobservable firm-specific characteristics that lead firms to be diversified, to the extent that these characteristics are constant over time. This mitigates the endogeneity problem emphasized by Campa and Kedia (2002), Graham, Lemmon, and Wolf (2002), Chevalier (2004), and Villalonga (2004). Fixed effects do not completely control for endogeneity, of course; the results could still be biased by unobservable firm-specific characteristics that vary through time. For instance, a given firm may adjust its R&D intensity in light of changing market conditions, conditions that may also affect the decision to diversify. However, these conditions are likely highly correlated with Tobin's q, which is included as a regressor, so the negative coefficient on the diversification index suggests that R&D and diversification are negatively correlated even when controlling for changes in the firm's investment opportunity set over time. Unlike the diversification-discount literature, the dependent

variable here is a choice variable, the firm's R&D expenditures controlling for (exogenous) changes in opportunities. For this reason the analysis here is relatively free from the endogeneity problems that are critical in studies of diversification's effect on firm value.

In short, even when differences in firm size, cash flow, and investment opportunities are taken into account, higher levels of diversification are still associated with lower R&D intensities. This finding is consistent with the myopia hypothesis. However, the results presented in Tables 2, 3, and 4 do not directly test the version of the myopia hypothesis advanced by Hoskisson and Hitt (1988, 1994), Hitt, Hoskisson, and Ireland (1990), and Hoskisson, Hitt, and Hill (1993). Their claim is that diversified multidivisional or M-form firms will do less R&D than nondiversified unitary or U-form firms.[12] Lacking specific data on organizational structure, however, the analysis presented here only compares single-segment firms and multiple-segment firms. While the multiple-segment firms in my sample are all almost certainly organized as M-form corporations, the single-segment "nondiversified" firms in my sample are themselves publicly traded corporations, many of which may also be organized as M-form firms. The results presented here show only that large, multiple-segment firms have higher R&D intensities than large, single-segment firms.

4. Measures of industry-adjusted R&D

The analysis reported in Table 4 controls for firm size and cash flow. It does not, however, control for the specific industries in which the diversified firms are active. If multiple-segment firms tend to cluster in low- or medium-tech industries, then regressions of R&D on diversification measures will report a negative relationship between conglomeration and innovation, even if the relationship has nothing to do with the organizational structure of a diversified firm. Moreover, there is evidence that firms tended to diversify into low-R&D industries during the 1960s

[12] A similar claim is that unrelated, or "broad-spectrum" diversification is harmful for innovation while related, or "narrow-spectrum" diversification is not [refs]. Relatedness is difficult to define, however, using SIC codes to characterize industries. The survival measure of relatedness proposed by Teece et al. (1994) is an attractive alternative, but is difficult to compute for a large sample of firms.

and 1970s (Ravenscraft and Scherer, 1987). To assess the effect of organizational structure on R&D intensity, it is necessary to control for industry.

Because the sample includes multi-industry firms, simply adding industry dummies to the pooled OLS regressions reported in Table 4 is not appropriate. Instead, I adopt a portfolio-matching technique similar to that used in Lang and Stulz (1994), Berger and Ofek (1995), Servaes (1996), and Klein (2001) to control for industry effects. This technique has not been used before in the literature on innovation and firm structure. For each multiple-segment firm in each year of the sample, I extract the 4-digit SIC code and sales for each industry segment. For each segment-year I search for matching firms from the set of all single-segment firms in the Compustat segment files meeting two criteria: (1) they are classified by Compustat as having in that year the same primary 2-digit SIC code as the diversified firm's segment, and (2) they have sales of at least 50 percent, and no more than 150 percent, of the sales of the diversified firm's segment.[13]

Using these criteria I identify, on average, 11.9 matching firms per segment-year. I was able to match over 90 percent of all segment-years in the sample. I then compute the median R&D intensity for all firms matching a particular segment-year, and construct sales-weighted averages of R&D intensity for each firm in each year. The final dataset thus contains exactly parallel samples of multiple-segment firms and matching portfolios of standalone firms, matched at the divisional level by year, size, and industry.

To measure industry-adjusted R&D I compare the matched portfolio observations with the diversified firms' observations. That is, suppose diversified firm i has total sales X_i, segments $j = 1, \ldots, n$, and segment sales x_i^j. Industry-adjusted R&D intensity R is thus given by $R_i - \sum_{j=1}^{n} r_i^j w_i^j$, where R_i is the diversified firm's own R&D intensity, r_i^j is the median R&D intensity of segment j's matching firms, and $w_i^j = x_i^j / X_i$ is the weight assigned to division j. Industry-

[13] The results are generally robust to changes in the matching procedure, such as matching at the 3-digit level or applying a tighter or looser size criterion.

adjusted R&D can be interpreted as the difference between the diversified firm's own R&D intensity and the R&D intensity it would have most likely had if each of its divisions were as R&D-intensive as the median standalone firm in the same industry and about the same size.

Table 5 presents mean and median industry-adjusted R&D for all multiple-segment firms, and then separately for firms with two, three, four, five, and six or more segments. Statistical significance is given by a paired *t*-test for the means and a signed-rank test for the medians. The first column reveals an "R&D discount"—analogous to the diversification discount for multiple-segment firms—ranging from −0.006 in 1980 to −0.013 in 1999. That is, in 1999 the R&D intensity of the average diversified firm was 1.3 percentage points lower than the R&D intensity of a size- and industry-matched portfolio of nondiversified firms. Like the previous results, this finding is consistent with the claim that diversified firms provide insufficient incentives for divisional managers to invest in R&D, despite the availability of funds from the internal capital market. And because the portfolio-matching technique controls for industry and size, the negative relationship between R&D and diversification cannot be explained in terms of differences in industry-specific differences in the innovation opportunity set. This approach also controls for other industry characteristics that could affect firms' incentives to do R&D, such as industry concentration, product life-cycles, the availability of licensing or other sharing arrangements, and so on.

[Table 5 about here]

The form of managerial myopia described by Hoskisson and Hitt (1988), Hitt, Hoskisson, and Ireland (1990), and Hoskisson, Hitt, and Hill (1993) results from the use of financial controls for evaluating divisional managers. This suggests that R&D underinvestment should be more pronounced at the most diversified firms, which are the firms most likely to use financial controls. However, the data presented in Table 5 do not bear this out, as R&D underinvestment is not generally increasing in the number of industry segments. Indeed, in the 1985 and 1995 cross sections R&D underinvestment is most pronounced among two-segment firms.

I next check to see if the negative industry-adjusted R&D figures could be driven by differences in size, cash flow, and investment opportunities between diversified and nondiversified firms. Table 6 reports the results of panel regressions of industry-adjusted R&D investment on a diversification measure ($1-H$), firm size (log sales), cash flow margin, and q (both measured as before) for the years 1980 to 1997. For these regressions I include single-segment as well as multiple-segment firms.[14] As seen in the table, the coefficient on the diversification measure is negative and highly significant, indicating that the negative relationship between diversification and R&D intensity documented in Table 4 remains even when controlling for the specific industries in which diversified firms are active. As in Table 4, the industry-adjusted R&D discount is smallest in the model with firm-fixed effects, suggesting that unobservable firm-specific characteristics explain part, but not all, of the negative relationship between diversification and R&D.

[Table 6 about here]

Because R&D, unlike market value, is ultimately a choice variable, this analysis is relatively free from the endogeneity problems plaguing the diversification-discount literature. It is unlikely that firms with low industry-adjusted R&D intensities subsequently diversify to increase their R&D, leading to a negative correlation between diversification and R&D even when the former has no effect on the latter. Moreover, the use of industry-adjusted R&D figures controls for the concern that specialized, high-R&D firms could diversify into low-R&D industries, implying a negative correlation between R&D and diversification when the result is driven by selection, not organizational form. If diversification does not affect R&D, then a firm's industry-adjusted R&D expenditures will not change as it adds or subtracts industry segments.

[14] Because these same single-segment firms are used to construct the pure-play portfolios, the median value of industry-adjusted R&D or the single-segment firms is zero.

5. Analysis of segment-level R&D and cash flow

The analysis described above used only three of the segment-level data items provided by the Compustat segment files: segment sales, segment SIC, and the number of segments per form. Compustat also provides R&D and cash flow information for each segment; analysis of these data provide further insight into the relationship between diversification and innovation. Here I follow Holthausen, Larcker, and Sloan (1994) in assuming that R&D investment decisions re made at the level of the business unit, not the firm. Internal capital markets provide resources that can be used to invest in innovation, but it is up to the managers of the business units to use those resources appropriately.

To examine the differences between standalone firms and business units of diversified corporations, I pool the Compustat data on single-segment firms with the segment-level data for diversified firms and regressed segment-level R&D-to-assets on segment size (measured as the log of the segment's sales), the segment's cash flow margin (defined as the segment's operating income plus depreciation plus R&D, all divided by segment sales), a constant, and a dummy indicating affiliation with an internal capital market—i.e., those segments that are subsidiaries of a diversified corporation. I also include a series of industry dummies at the 2-digit SIC level. Like Shin and Stulz (1998), I analyze separately the smallest and the largest segments of multiple-segment firms. This allows more precise inferences about the operation of the internal capital market. It also handles the problem that diversified firms are more likely than nondiversified firms to have separate R&D centers (see Cardinal and Opler, 1995), making it difficult to draw inferences about divisional R&D decisions using firm-wide R&D levels. (Unfortunately, the existing myopia literature relies almost exclusively on firm-level data.)

Results of these cross-sectional regressions are presented in Table 7. The results in Panel A use all single-segment firms plus the smallest segments of multiple-segment firms, while the results in Panel B use all single-segment firms plus the largest segments of multiple-segment firms. The results do not strongly support the myopia hypothesis. In both panels and in all five cross-

sections the coefficients on the dummy for internal-capital-market affiliation is negative, though it is statistically significant only in two of the cross sections, and only for the regressions including the smallest segments of diversified firms. In other words, there is some evidence that small segments of diversified firms have lower R&D intensities than standalone segments, controlling for segment size, cash flow, and industry, but this relationship does not hold for larger segments.

[Table 7 about here]

This is inconsistent with the claim that divisional managers are reluctant to invest in R&D because their performance is tied exclusively to short-term profit targets. Financial controls are more common at large subsidiaries, whose activities are frequently complex and difficult for outsiders to assess, than at small subsidiaries, which can be more easily monitored (Gates and Egelhoff, 1986). Just as startups in emerging industries rely on venture capitalists for funding, guidance, and evaluation, small segments of diversified corporations are more likely to rely on the corporate office for these same functions. If R&D underinvestment is driven by myopia among divisional managers, then underinvestment should generally be a more serious problem at large segments rather than small segments.

If R&D underinvestment is driven by internal-capital-market inefficiencies, however, then smaller segments—which are more dependent on funding from the corporate office than larger firms—should be the most myopic. Larger segments are more likely to generate sufficient cash flows to finance R&D even without the support of an internal capital market. Similarly, Wulf (1998) argues that large divisions are more likely to have informational advantages that can be exploited through influence activities to extract additional resources from the central office, leading to underinvestment by the smallest segments. The results of Table 7 are consistent with the idea that small segments do less R&D than standalone peers because some of their cash flows are diverted to support other activities within the firm, while large segments are able to prevent such outflows.

Further evidence comes from the relationship between R&D intensity and the within-firm variance of industry investment opportunities. Rajan, Servaes, and Zingales (2000) argue that the greater the diversity of divisional resources and investment opportunities, the more likely that corporate resources will be shifted in the wrong direction, i.e., from divisions with more resources and more desirable investment opportunities to those with fewer resources and less desirable investment opportunities. In their model, the corporate office allocates resources to projects but cannot commit to the ex post division of the surplus. Managers of divisions with more resources or better investment opportunities than other divisions may thus favor "defensive" investments that offer lower returns, but allow them to keep more of the surplus. Firm-level investment will then be more efficient the more similar are divisional resources and opportunities. Using a panel of diversified firms the 1980s and early 1990s, they show that firm value is negatively related to the within-firm variation in divisional investment opportunities (proxied by size-weighted industry q).

To see if this form of internal-capital-market inefficiency affects R&D intensity I return to the firm-level measures of R&D and diversification and compute, for each firm, the variance of industry-adjusted segment q and use this as an additional regressor. Here I use only the multiple-segment firms in the sample. Results are presented in Table 8. As seen in the table, industry-adjusted R&D intensity is decreasing in the within-firm variance of industry investment opportunities. This suggests that the greater the potential for intra-firm conflicts over the allocation of resources, the lower the firm's commitment to investments in innovation, controlling for firm size, industry, cash flow, and the firm's overall investment opportunities. Again, these results seem more consistent with an inefficient internal-capital-markets explanation than an explanation based on managerial myopia.

[Table 8 about here]

6. Conclusions and directions for future research

This paper shows that diversified firms have lower R&D intensities than nondiversified firms, even when controlling for differences in firm size, cash flow, and the distribution of activities across industries. Moreover, R&D intensity is generally declining in the level of diversification. This suggests that the corporate refocusing movement of the 1980s and early 1990s could be a driver of the recent surge in private-sector R&D. Looking within individual segments, R&D underinvestment appears to be most pronounced among the smallest segments. This suggests that inefficient internal capital markets, rather than managerial myopia, may be driving the negative relationship between diversification and R&D.

These results are preliminary, and much more work remains to be done. The analysis reported here considers a single measure of innovation, R&D investment. Of course, R&D is not a measure of innovation per se, but rather a measure of the input into the innovative process. An alternative approach would look at patents, an indicator of the output of that process. For example, patents eventually granted per unit of R&D can be interpreted as a measure of the productivity of R&D. Of course, patent data have limitations as well. Patents measure the technological potential of an innovation, not its economic importance. Many innovations are not patentable, and many patentable innovations are not patented. Moreover, patents are correlated with factors other than pure innovation. For example, process innovations are much less likely to be patented than product innovations; large firms may be more likely to patent than individual entrepreneurs; and patent propensity varies widely by industry. Still, comparison of the present results with results using patent measures should be instructive. More generally, the analysis could be expanded by using broader measures of "corporate entrepreneurship" such as risk-taking, and the introduction of innovative organizational practices (Barringer and Bluedorn, 1999).

I also hope to extend the analysis through time and across countries. A companion paper (Klein, 2004) looks at the relationship between diversification and innovation during the conglomerate merger wave of 1960s, and the relationship between organizational structure, innova-

tion, and long-term firm performance. I also intend to do some cross-country comparisons of the relationships explored in these papers. Corporate governance and managerial incentive structures are very different in Continental Europe, Japan, and elsewhere, and it may be instructive to compare the effects of diversification on innovation in the U.S. with its effects in alternative institutional settings.

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Table 1: Descriptive Statistics

Sample includes all firms on Compustat industrial, full coverage, and research files for which industry-segment information was available.

Year		1980	1985	1990	1995	1999
Number of firms		1709	2465	3468	5667	4586
Total assets	Mean	1153	1331	1877	1741	2190
($ millions)	Median	104	89	93	77	145
R&D-to-assets ratio	Mean	3.94%	6.78%	7.75%	10.24%	10.93%
(percent)	Median	2.03%	3.22%	3.18%	4.00%	5.01%
Cash flow margin	Mean	5.13%	3.76%	3.68%	3.35%	0.95%
(percent)	Median	3.80%	4.09%	4.58%	5.08%	4.62%
Investment rate	Mean	2.13%	2.31%	2.33%	2.21%	1.33%
(percent)	Median	0.21%	0.24%	0.20%	0.29%	0.18%
Number of segments	Mean	2.19	1.86	1.69	1.48	1.98
(numbers)	Median	2.00	1.00	1.00	1.00	1.00
Sales-weighted Herfindahl	Mean	68.80%	76.58%	82.04%	87.19%	78.33%
(percent)	Median	100.00%	100.00%	100.00%	100.00%	100.00%
Dummy for missing R&D	Mean	0.516	0.486	0.478	0.459	0.430

Table 2: R&D Intensity by Number of Industry Segments

Average and median R&D intensity (R&D divided by total assets) by number of industry segments. Includes observations with usable R&D data only.

	Segments					
	1	2	3	4	5	6 or more
1980						
mean	0.044	0.034	0.022	0.029	0.022	0.021
median	0.026	0.022	0.019	0.017	0.017	0.013
std dev	0.064	0.034	0.024	0.030	0.020	0.017
n	414	120	116	92	49	37
1985						
mean	0.066	0.042	0.032	0.028	0.031	0.026
median	0.041	0.026	0.019	0.019	0.020	0.012
std dev	0.092	0.053	0.036	0.027	0.031	0.026
n	791	183	125	97	42	28
1990						
mean	0.077	0.040	0.034	0.029	0.030	0.020
median	0.043	0.020	0.015	0.018	0.017	0.009
std dev	0.107	0.054	0.054	0.031	0.038	0.027
n	1279	207	133	94	45	42
1995						
mean	0.097	0.042	0.031	0.028	0.027	0.027
median	0.047	0.019	0.018	0.015	0.015	0.021
std dev	0.138	0.065	0.044	0.033	0.033	0.026
n	2429	279	172	85	43	39
1999						
mean	0.122	0.088	0.057	0.038	0.043	0.040
median	0.063	0.046	0.028	0.016	0.023	0.022
std dev	0.165	0.111	0.073	0.052	0.056	0.068
n	1643	272	330	187	87	75

Table 3: R&D Intensity by Herfindahl Index of Diversification

Average and median R&D intensity (R&D divided by total assets) by Herdindahl index of diversification. The Herfindahl index is computed as the sum of squared segment sales divided by the square of total firm sales. Includes observations with usable R&D data only.

	Herfindahl index weighted by segment sales				
	H=1	0.8≤H<1	0.6≤H<0.8	0.4≤H<0.6	H<0.4
1980					
mean	0.043	0.014	0.030	0.028	0.028
median	0.025	0.005	0.020	0.016	0.020
std dev	0.073	0.018	0.030	0.031	0.025
n	419	23	84	147	155
1985					
mean	0.066	0.028	0.040	0.033	0.033
median	0.041	0.013	0.028	0.018	0.024
std dev	0.092	0.033	0.039	0.044	0.031
n	800	46	96	172	152
1990					
mean	0.077	0.039	0.040	0.032	0.031
median	0.042	0.009	0.019	0.016	0.022
std dev	0.106	0.065	0.051	0.053	0.032
n	1296	45	111	188	160
1995					
mean	0.097	0.041	0.040	0.035	0.029
median	0.046	0.007	0.020	0.018	0.022
std dev	0.138	0.092	0.051	0.048	0.028
n	2446	70	147	235	149
1999					
mean	0.120	0.053	0.062	0.063	0.043
median	0.062	0.022	0.024	0.029	0.023
std dev	0.164	0.068	0.094	0.091	0.057
n	1682	117	221	359	215

Table 4: Panel Regressions of R&D on Diversification and Control Variables, 1980–97

Dependent variable is R&D divided by total assets. Diversification is measured as $1-H$, where H is a sales-weighted Herfindahl index of diversification. Heteroskedasticity-consistent standard errors given in parentheses. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively. The panel excludes firms with less than $100 million in annual sales. All specifications include year-fixed effects.

	Total	Within-firm	Variance components
Constant	0.0274***	0.0712***	0.0431***
	(0.0025)	(0.0130)	(0.0057)
Diversification index	−0.0046***	−0.0029***	−0.0035***
	(0.0009)	(0.0011)	(0.0014)
Log(sales)	−0.0032***	0.0007	−0.0008
	(0.0002)	(0.0005)	(0.0008)
Cash flow margin	0.2637***	0.0125***	0.0271**
	(0.0115)	(0.0033)	(0.0120)
Tobin's q	0.0056***	−0.0004	0.0002
	(0.0006)	(0.0003)	(0.0005)
R^2	0.304	0.886	0.009
Observations	13,150	13,150	13,150

Table 5: Industry-Adjusted R&D Intensity for Multiple-Segment Firms

Average and median industry-adjusted R&D intensity by number of industry segments. Industry-adjusted values computed by subtracting from each firm-year a sales-weighted average of the median industry values corresponding to each of the firm's segments in that year. ***, **, and * indicate the reported value is statistically different from zero at the 1, 5, and 10 percent levels, respectively.

	All multiple-segment firms	segments				
		2	3	4	5	6 or more
1980–97						
mean	−0.009 ***	−0.010 ***	−0.010 ***	−0.007 ***	−0.008 ***	−0.006 ***
median	−0.005 ***	−0.004 ***	−0.006 ***	−0.003 ***	−0.004 ***	−0.004 ***
std dev	0.029	0.033	0.027	0.030	0.032	0.020
n	5,790	1,702	1,587	1,212	692	597
1980						
mean	−0.006 ***	−0.004 **	−0.006 ***	−0.006 ***	−0.009 ***	−0.006
median	−0.005 ***	−0.003 **	−0.004 ***	−0.007 ***	−0.007 ***	−0.006 **
std dev	0.021	0.026	0.021	0.017	0.014	0.015
n	346	128	103	66	30	19
1985						
mean	−0.012 ***	−0.014 ***	−0.009 ***	−0.013 ***	−0.006	−0.003
median	−0.008 ***	−0.008 ***	−0.006 ***	−0.011 ***	−0.005	−0.005
std dev	0.046	0.062	0.025	0.026	0.021	0.021
n	401	186	103	76	21	15
1990						
mean	−0.007 **	−0.001	−0.014 ***	−0.010 ***	−0.008	−0.005
median	−0.007 ***	−0.005 ***	−0.009 ***	−0.006 ***	−0.010 **	−0.006
std dev	0.062	0.087	0.030	0.024	0.028	0.024
n	458	203	126	76	30	23
1995						
mean	−0.013 ***	−0.017 ***	−0.009 ***	−0.003	−0.009 **	−0.010 **
median	−0.006 ***	−0.008 ***	−0.006 ***	−0.002	−0.007 ***	−0.005 *
std dev	0.062	0.077	0.046	0.047	0.023	0.025
n	548	275	160	55	32	26
1999						
mean	−0.013 ***	−0.012 **	−0.007	−0.028 ***	−0.035 ***	0.006
median	−0.009 ***	−0.010 ***	−0.007 ***	−0.013 ***	−0.013 ***	0.004
std dev	0.095	0.104	0.096	0.067	0.070	0.045
n	827	399	260	89	52	27

Table 6: Panel Regressions of Industry-Adjusted R&D on Diversification and Control Variables, 1980–97

Dependent variable is R&D divided by total assets, adjusted for industry by subtracting from each firm-year a sales-weighted average of the median industry values corresponding to each of the firm's segments in that year. Diversification is measured as $1-H$, where H is a sales-weighted Herfindahl index of diversification. Heteroskedasticity-consistent standard errors given in parentheses. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively. The panel excludes firms with less than $100 million in annual sales. All specifications include year-fixed effects.

	Total	Within-firm	Variance components
Constant	−0.0145***	0.0203	0.0046
	(0.0024)	(0.0168)	(0.0056)
Diversification index	−0.0141***	−0.0055***	−0.0076***
	(0.0010)	(0.0016)	(0.0020)
Log(sales)	0.0001	−0.0006	−0.0009
	(0.0003)	(0.0007)	(0.0007)
Cash flow margin	0.1496***	0.0178***	0.0394***
	(0.0083)	(0.0045)	(0.0013)
Tobin's q	0.0024***	−0.0001	0.0007
	(0.0005)	(0.0003)	(0.0006)
R^2	0.146	0.727	0.013
Observations	12,096	12,096	12,096

Table 7: Cross-Sectional Regressions of Segment-Level R&D on Internal-Capital-Market Affiliation and Control Variables, by Segment Size

Dependent variable is segment R&D divided by segment total assets. An indicator variable, "internal-capital-market affiliation," is used to identify segments of diversified firms; the other observations are standalone firms. Sales and cash flow also measured at the segment level. Industry dummies (2-digit SIC level) included. Heteroskedasticity-consistent standard errors given in parentheses. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively.

	1980	1985	1990	1995	1999
Panel A: Single-segment firms and smallest segments of diversified firms					
Constant	0.0203***	0.0280***	0.0395***	0.0679***	0.0799***
	(0.0066)	(0.0063)	(0.0065)	(0.0068)	(0.0101)
Internal-capital-market affiliation	−0.0074	−0.0036	−0.0127	−0.0322***	−0.0490***
	(0.0068)	(0.0075)	(0.0082)	(0.0094)	(0.0125)
Log (segment's sales)	−0.0035***	−0.0044***	−0.0067***	−0.0121***	−0.0131***
	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0016)
Segment's cash flow margin	0.0474***	0.0056	0.0165	0.0414***	0.0167
	(0.0169)	(0.0116)	(0.0138)	(0.0107)	(0.0103)
R^2	0.312	0.317	0.274	0.320	0.286
Observations	498	870	1368	2372	1427
Panel B: Single-segment firms and largest segments of diversified firms					
Constant	0.0165***	0.0278***	0.0383***	0.0664***	0.0806***
	(0.0064)	(0.0060)	(0.0063)	(0.0067)	(0.0101)
Internal-capital-market affiliation	0.0013	0.0030	−0.0027	−0.0125	−0.0131
	(0.0063)	(0.0065)	(0.0072)	(0.0085)	(0.0117)
Log (segment's sales)	−0.0034***	−0.0048***	−0.0065***	−0.0118***	−0.0131***
	(0.0011)	(0.0010)	(0.0010)	(0.0011)	(0.0015)
Segment's cash flow margin	0.0652***	0.0241**	0.0199	0.0396***	0.0169*
	(0.0174)	(0.0116)	(0.0135)	(0.0107)	(0.0102)
R^2	0.324	0.313	0.279	0.322	0.294
Observations	513	898	1402	2398	1441

Table 8: Panel Regressions of Industry-Adjusted R&D on Diversification, Internal-Capital-Market Measures, and Control Variables, 1980–97, Multiple-Segment Firms Only

Dependent variable is R&D divided by total assets, adjusted for industry by subtracting from each firm-year a sales-weighted average of the median industry values corresponding to each of the firm's segments in that year. Diversification is measured as the natural log of the number of segments. Heteroskedasticity-consistent standard errors given in parentheses. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively. The panel excludes firms with less than $100 million in annual sales. Firm- and year-fixed effects included.

	Total	Total	Total
Constant	−0.0433 ***	−0.0451 ***	−0.0458 ***
	(0.0022)	(0.0027)	(0.0028)
Log (number of segments)	0.0034 ***	———	0.0018
	(0.0009)		(0.0013)
Variance of imputed segment *q*	———	−0.0052 ***	−0.0053 ***
		(0.0012)	(0.0012)
Log(sales)	0.0012 ***	0.0019 ***	0.0018 ***
	(0.0003)	(0.0003)	(0.0004)
Cash flow margin	0.1078 ***	0.1232 ***	0.1228 ***
	(0.0068)	(0.0077)	(0.0077)
Tobin's *q*	0.0090 ***	0.0092 ***	0.0093 ***
	(0.0007)	(0.0007)	(0.0008)
R^2	0.117	0.131	0.131
Observations	5,426	4,317	4,317