

Capitalization versus Expensing: Evidence on the Uncertainty of Future Earnings from Capital Expenditures versus R&D Outlays

S.P. Kothari

Sloan School of Management
Massachusetts Institute of Technology
50 Memorial Drive, E52-325
Cambridge, MA 02142
E-mail: Kothari@mit.edu
617-253-0994

Ted E. Laguerre

Analysis Group
tlaguerre@ag-inc.com

and

Andrew J. Leone

William E. Simon Graduate School of Business Administration
University of Rochester, Rochester, NY 14627
E-mail: Leone@simon.rochester.edu
716 275-4714

First draft: June 1998

Revised: May 2001

We are grateful to Anwer Ahmed, Joy Begley, John Core, Elizabeth Eccher, Jerry Feltham, Wayne Guay, David Guenther, Rob Ingram, Shelly Jain, Steve Penman (editor), Larry Weiss, Paul Zarowin, and especially an anonymous referee and Jerry Zimmerman, and seminar participants at the University of British Columbia, University of Colorado at Boulder, INSEAD, University of Michigan, University of Tilburg, and University of Technology in Sydney for helpful comments on the paper. We thank the Bradley Policy Research Center at the Simon School and the John M. Olin Foundation for financial support.

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I. INTRODUCTION

We present evidence on the relation between R&D expenditures and the uncertainty of future benefits from those investments using financial data from 1972-1997 for a large sample of firms. Existing empirical research focuses mainly on examining the relevance of accounting disclosures about R&D expenditures (i.e., association of R&D expenditures with security prices or returns). We believe the evidence from our study on the uncertainty of benefits from R&D expenditures, combined with the evidence from previous research on the relevance of R&D expenditures for security prices, will contribute to the on-going debate among academics, practitioners, and regulators on accounting for R&D. However, based on the evidence in the paper, we are unable to make an unambiguous policy recommendation as to whether R&D expenditures should be expensed or capitalized.

An important issue facing the U.S. and international accounting standard setters is the financial reporting of corporate R&D expenditures. U.S. GAAP (Statement of Financial Accounting Standards, SFAS, No. 2, 1974, and Proposed Statement of Position dated April 22, 1997) requires corporations to immediately expense their R&D expenditures. By contrast, International Accounting Standard No. 9 (1978) and the International Accounting Standards Committee's Exposure Draft E60 (1997) on intangible assets allow corporations to capitalize development expenditures and require expensing only research outlays.

The U.S. standard on the accounting treatment of R&D expenditures (i.e., SFAS No. 2) is likely influenced by the standard setters' perceived degree of uncertainty about future economic benefits from current research and development outlays. Paragraphs 48, 49, and 50 of SFAS No. 2 summarize FASB's rationale for requiring immediate expensing of R&D expenditures. FASB applied the principles for recognizing costs as expenses as set forth in Accounting Principles Board Statement No. 4, paragraphs 156-160. FASB states "...there is often a high degree of

uncertainty about whether research and development expenditures will provide any future benefits” (paragraph 49). In paragraph 50 it states “...the relationship between current research and development costs and the amount of resultant future benefits to an enterprise is so uncertain that capitalization of any research and development costs is not useful in assessing the earnings potential of the enterprise.” The significant consideration of the uncertainty of future benefits from R&D expenditures in the standard-setting process suggests standard setters consider the usefulness of a balance sheet in credit (or lending) decisions to be an important factor.

FASB continues to employ the degree of uncertainty of future benefits as a criterion in determining whether a given cost should be capitalized or expensed. This is seen from FASB’s definition of assets as “probable future economic benefits obtained or controlled by a particular entity as a result of past transactions or events” (Statement of Financial Accounting Concepts No. 6, 1980). Thus, the greater the uncertainty of future economic benefits from R&D expenditures, the weaker would be the case in favor of capitalization (i.e., recognition of R&D as an asset on the balance sheet) even if *on average* the future benefits are positive.

The current debate among academics and practitioners on capitalization versus expensing of R&D expenditures has been without direct empirical evidence on the uncertainty of future earnings and cash flows attributable to current R&D outlays. Bierman and Dukes (1975) is the only study to our knowledge that comes close to examining the relation between R&D and the uncertainty of future benefits. They survey the literature at the time and conclude that FASB overestimates the risk of future benefits from R&D investments. They argue that when looking at a company’s R&D investment portfolio, the risks are lower than for an individual project.¹ However, no direct evidence is offered on the degree of risk of future benefits (e.g., earnings or cash flows) associated with R&D investments.

¹ SFAS No. 2 deems it “not appropriate to consider accounting for research and development activities on an aggregate or total-enterprise basis” (paragraph 52). The reason is that “For accounting purposes the expectation of future benefits generally is not evaluated in relation to broad categories of expenditures on an enterprise-wide basis but rather in relation to individual or related transactions or projects” (paragraph 52).

Recent research on the accounting treatment of R&D expenditures (e.g., Chambers, Jennings, and Thompson, 1998, Deng and Lev, 1997, and Lev and Sougiannis, 1996, and Sougiannis, 1994) provides compelling evidence that *on average* the market assigns a statistically and economically significant valuation to corporate R&D activity. This is interpreted as R&D expenditures meeting the relevance criterion underlying accounting standard setting. The evidence, however, does not shed light directly on the degree of uncertainty of the economic benefits to R&D activity compared to other expenditures that corporations typically capitalize. Our objective in this study is to provide direct evidence on the relative degree of uncertainty of future earnings attributable to current R&D investments and to current capital expenditures. The motivation stems from the fact that, whereas existing evidence is largely on the relevance of R&D, standard setting is guided by a trade-off between relevance and uncertainty of future benefits.

The trade-off between relevance and uncertainty of future benefits is in the spirit of the relevance-reliability trade-off that is often discussed in the context of accounting standards (e.g., SFAC No. 2, 1980, Watts and Zimmerman, 1986, pp. 205-206, and Revsine, Collins, and Johnson, 1998, p. 17). We, however, use the phrase “uncertainty of future benefits,” not reliability. Accounting information is deemed to be reliable if it “is free of error and bias, is factual, verifiable, and neutral” (Weygandt, Kieso, and Kell, 1996, p. 496, and SFAC No. 2). We believe R&D expenditures would meet the above definition of reliability because the R&D expenditures incurred by a firm in a fiscal period can be reasonably accurately established. However, standard setters are also concerned about the likelihood that future benefits will be realized. If the definition of reliability is broadened to include uncertainty of future benefits from costs incurred currently, then our study provides evidence on the reliability component of the relevance-reliability trade-off in the context of R&D accounting. Interestingly, most readers (including Baruch Lev) of our study at least initially interpret uncertainty of future benefits to be synonymous with reliability.

Summary of results. The empirical analysis compares the relative contributions of current R&D and capital expenditures to future earnings variability. We use the standard deviation of realized future earnings as a proxy for the uncertainty of future benefits. We analyze a sample of over 50,000 firm-year observations from 1972 to 1992 with data on R&D and capital expenditures and estimates of future earnings variability. Evidence is consistent with the hypothesis that R&D investments generate more uncertain future benefits. Specifically, in a regression of future earnings variability on R&D, capital expenditures, and other economic determinants of earnings variability like leverage, firm size, industry membership, growth, and return variability, the coefficient on R&D is about three times as large as that on capital expenditures. This difference is not only statistically highly significant, but it translates into an important economic difference. If a firm were to substitute R&D investments for all of its capital expenditures, our analysis suggests the increase in earnings variance will be approximately 70%. This conclusion is robust to a battery of tests summarized in section V. Notwithstanding the compelling evidence that R&D investments produce more uncertain benefits than capital expenditures, we do not make a policy prescription because we have no knowledge of the weights to be assigned to relevance and to uncertainty in trading-off one against the other.

Outline of the paper. Section II surveys the arguments in the literature for and against R&D capitalization and summarizes research on the relevance of R&D cost information in financial statements. Section III describes the simulation and research design we use to test the hypothesis that benefits from R&D investments are more uncertain than capital expenditures. Section IV presents details of data, sample selection, and descriptive statistics. Section V contains the results of empirical analysis and sensitivity tests. We conclude in section VI.

II. ACCOUNTING FOR R&D AND RELATED RESEARCH

This section briefly reviews the arguments that regulators, academics and practitioners often make for and against expensing R&D expenditures. We also summarize findings of the

accounting research on R&D expensing versus capitalizing. Almost invariably previous studies focus on evaluating the relevance of R&D expenditures. We are unaware of scientific evidence on the relative degree of uncertainty of benefits from R&D expenditures versus capital expenditures.

Rationale for expensing R&D expenditures. Some favor immediate expensing of R&D expenditures on the grounds that reliable evidence of future economic benefits from current R&D activity is lacking. For example, the Association for Investment Management and Research (AIMR) (1993) concurs with the FASB's expensing of R&D because "it usually is next to impossible to determine in any sensible or codifiable manner exactly which costs provide future benefit and which do not" (pp. 50-51). While *on average* R&D expenditures might generate future economic benefits, the standard setters' concern appears to be the lack of compelling evidence of future benefits to each firm and in each instance to justify R&D capitalization (see SFAS No. 2, paragraph 52). Moreover, not impressed by the existence of future benefits, AIMR concludes that the future benefits are so unrelated to costs incurred that the information in the capitalized amount of R&D expenditures is largely "irrelevant to the investment valuation process" (1993, pp. 50-51). This can be interpreted as neither capitalization nor expensing is particularly helpful or harmful in investors' valuation of corporations for their investment decisions.

The expensing of R&D is consistent with the usefulness of a balance sheet in credit decisions (i.e., in lending and in writing debt contracts) being an important factor in the standard-setting process. The high degree of uncertainty of future benefits from R&D expenditures and the generally negligible collateral value of R&D investments make R&D less attractive for capitalization. R&D expenditures have low collateral value in part because there typically are few alternative uses for them or the liquidation value in the event of project failure is not substantial. This is unlike the collateral value of tangible assets like buildings, plant, and equipment. Therefore, the agency cost of borrowing against intangible R&D assets is high and

the debt capacity of R&D expenditures (intangible assets) is low. Empirical evidence bears out this prediction. For example, Barclay, Smith, and Watts (1995) show that R&D intensive industries like biotechnology, pharmaceuticals, and computers and software (which are also industries with growth options or investment opportunities) finance their businesses mostly with equity.²

Rationale for capitalizing R&D expenditures. Proponents of R&D capitalization point to the evidence that (as if) earnings that reflect the effects of R&D capitalization and amortization are significantly more highly associated with stock prices and returns than GAAP earnings with immediate R&D expensing. This is interpreted as “the R&D capitalization process yields value-relevant information to investors” (Lev and Sougiannis, 1996, p. 134) and as contradicting FASB’s objection to R&D capitalization in SFAS No. 2 that direct evidence of R&D expenditures and specific future benefits does not exist. The proponents therefore argue that it behooves standard setters to issue a new standard allowing corporations to capitalize R&D expenditures.

Previous research. A large body of previous research examines issues surrounding the accounting treatment of R&D expenditures. Early research following the promulgation of SFAS 2 in 1974 focuses on the standard’s economic consequences. Economic consequences are estimated from security price changes and from the standard’s effect on corporate R&D expenditures (e.g., Dukes, Dyckman, and Elliott, 1980, Horwitz and Kolodny, 1980, Elliott, Richardson, Dyckman, and Dukes, 1984, and Wasley and Linsmeier, 1992). This research produces mixed evidence in part because it lacks power to detect effects on R&D activity in the presence of confounding economic events like the energy crisis and recession in the mid-1970s (Ball, 1980).

² We are aware that there are alternative theories and explanations for cross-sectional variation in leverage. For example, pecking order and static tradeoff are alternative theories of capital structure (see Shyam-Sunder and Myers, 1999, for a discussion and empirical evidence). Our objective in discussing the agency-cost based theory of capital structure is merely to state that the expensing treatment of R&D is consistent with that theory, but we acknowledge that it might be consistent with other theories as well.

Much of the recent research on this topic focuses on examining the value relevance of R&D expenditures. Lev and Sougiannis (1996) and Chambers, Jennings, and Thompson (1998) show that financial statements restated to reflect economically plausible rates of amortization applied to hypothetically capitalized R&D investments are more highly associated with security prices than with financial-statement numbers based on immediate expensing of R&D. Chambers et al. (1998) find that in a price level regression the estimated coefficient on capitalized R&D expenditures is indistinguishable from that on property, plant, and equipment (PP&E). The equality of the two coefficients is, however, not a sufficient condition to conclude that future benefits from R&D and PP&E are equally uncertain. The reason is that the market's pricing is based on the amount, timing, and systematic uncertainty of future cash flows, whereas our focus is only on the (systematic and unsystematic) uncertainty of future cash flows, which cannot be unambiguously inferred from the price-level regression coefficients. Other research shows that advertising and R&D expenditures have positive impacts on the market value of a firm (Hirschey and Weygandt, 1985, Woolridge, 1988, and Chan, Martin, and Kensinger, 1990). Collectively, these studies argue that because R&D investments are on average associated with stock prices or because they are on average value enhancing, they should be capitalized and amortized rather than immediately expensed.

III. SIMULATION AND RESEARCH DESIGN

The main hypothesis we test is whether the variability of future earnings due to R&D investments is greater than that due to capital expenditures. We regress the standard deviation of future earnings on current R&D, capital expenditures, and other economic determinants of earnings variability, which are included as control variables in the regression. A comparison of the coefficients on R&D and capital expenditures provides an indication of the relative sensitivity of earnings variability to R&D and capital expenditures. To demonstrate that the above regression approach using realized earnings variability uncovers a relation between the market-forecasted earnings variability and investments we perform a simulation that is

summarized below. The simulation shows that if an R&D investment is expected to generate a more uncertain future earnings stream than capital expenditures, then in a regression to explain *realized* earnings variability, the coefficient on R&D will be greater than that on capital expenditures.³

Simulation

The simulation is designed to formalize the intuition that the more uncertain the future benefit, the larger is the coefficient on current investment in a regression of the standard deviation of future benefits on the investment. The simulation has two parts: (1) simulate R&D, capital expenditures, and future earnings; and (2) estimate a regression of the standard deviation of realized future earnings on R&D and capital expenditures. For each simulated firm we generate annual R&D, capital expenditures, and future earnings data. Below we show the relation between the uncertainty (standard deviation) of future benefits and R&D expenditures. The same analysis applies when capital expenditures are included. We do not include capital expenditures in equations below to keep the notation less complicated.

Assume an R&D investment in year t , RDI_t , produces uncertain future benefits over T_R years, denoted as X_{t+k,RDI_t} for $k = 1$ to T_R . Also assume that $X_{t+k,RDI_t} \sim N[RDI/T_R, (RDI/T_R)^2\sigma^2(RD)]$, which means expected benefits over T_R years sum to the amount invested, RDI_t . The variability of the benefits is a function of the $\sigma^2(RD)$ parameter and the amount of investment.

Earnings are defined as the sum of realized benefits from R&D expenditures in the past T_R years.⁴ Formally,

$$X_{t+k} = X_{t+k,RDI_{t+k-1}} + X_{t+k,RDI_{t+k-2}} + \dots + X_{t+k,RDI_{t+k-T_R}} \quad (1)$$

³ This approach is similar to the Fama -MacBeth regression methodology used extensively in the literature (see Fama and MacBeth, 1973, Fama and French, 1992, and Kothari and Zimmerman, 1995).

⁴ Unlike historical cost GAAP earnings, earnings as we define in the simulation analysis do not deduct the R&D outlay or depreciation of current and past capital expenditures from the realized future benefits. However, we obtain qualitatively similar results when earnings are calculated net of R&D and depreciation expenses in the simulations as well as in actual data.

Assuming independent R&D investments over time, the variance of earnings X_{t+k} is

$$V(X_{t+k}) = \sum_{p=1 \text{ to } TR} (1/T_R)^2 (X_{t+k, RDI_{t+k-p}})^2 \sigma^2(RD). \quad (2)$$

From eq. (2), the marginal variability of earnings as a function of \$1 R&D investment in a given year is

$$\frac{\partial V(X_{t+k})}{\partial (X_{t+k, RDI_{t+k-p}})^2} = \left(\frac{1}{T_R}\right)^2 \mathbf{s}^2(RD) \quad (3)$$

and the marginal variability of earnings as a function of \$1 of cumulative R&D investment is

$$\frac{\partial V(X_{t+k})}{\partial \sum_{p=1 \text{ to } TR} (X_{t+k, RDI_{t+k-p}})^2} = \left(\frac{1}{T_R}\right)^2 \mathbf{s}^2(RD). \quad (4)$$

Eqs. (3) and (4) suggest that the marginal impact of R&D expenditures on earnings variability can be estimated by regressing earnings variability on either current R&D investment or the cumulative investment (over the useful life). The cumulative investment times the marginal impact from eq. (3) or (4) gives R&D investments' contribution to total earnings variability.⁵ The same logic applies to capital expenditures and it also applies to a more realistic setting in which a firm makes both R&D and capital expenditures annually.

In the simulation analysis, we simulate R&D and capital expenditures and earnings (i.e., summed future benefits). Earnings variability is defined as the standard deviation of realized earnings for five years. Use of standard deviation instead of variance is designed to reduce skewness in the distribution of estimated variances resulting from extreme observations and because we use five annual observations for each firm in the actual data. However, the results are qualitatively similar using variance or standard deviation. The simulations show that the coefficients on R&D and capital expenditures increase in the variability of future benefits from those expenditures. This provides a basis to regress the standard deviation of realized future

⁵ Since the assumption of serial independence of R&D expenditures may not hold, the partial derivative in eq. (3) will reflect the impact not only of the R&D outlay in a particular period, but also the variability attributable to the R&D correlated with that year's R&D. This bias does not apply to eq. (4).

earnings on R&D and capital expenditures to test the hypothesis that earnings variability is more sensitive to a firm's R&D outlays than to capital expenditures.

Research design using actual data

We estimate the following annual cross-sectional model (firm subscript i is suppressed) that includes additional determinants of earnings variability as control variables:

$$SD(E_{t+1,t+5}) = \alpha + \beta_{1t} \text{CapEx}_t + \beta_{2t} \text{R\&D}_t + \beta_{3t} \text{MV}_t + \beta_{4t} \text{Leverage}_t + \text{error}_{t+1,t+5} \quad (5)$$

where

$SD(E_{t+1,t+5})$ is the standard deviation of earnings before extraordinary items and discontinued operations; the standard deviation is calculated using five annual earnings observations for years $t+1$ through $t+5$; each earnings observation is deflated either by the book value of equity, BVE, or by stock price, P , at the beginning of the period t ;

R\&D_t is research and development per share, deflated by BVE or P ;

CapEx_t is the capital expenditure per share, deflated by BVE or P ;

MV_t is the natural logarithm of the market capitalization of equity at the end of year t ; and

Leverage_t is the ratio of long-term debt to the market value of equity plus long-term debt, both at the end of year t .⁶

We repeat the regressions using the net property, plant, and equipment assets as reported by a firm and our estimate of the capitalized book value of R&D assuming a five-year useful life and straight-line depreciation. We expect the coefficient on R&D investment in the regression to exceed that on capital expenditures. While this may not be apparent in any one cross-section examined, by aggregating the coefficients from several annual cross-sectional regressions, we hope to estimate the sensitivity of earnings variability to investments with considerable precision. However, we do not have a rigorous theoretical prediction about the relative magnitudes of the coefficients on R&D and capital expenditures. Nor do we believe financial accounting standard setters have in mind a particular cut-off magnitude of the sensitivity of

⁶ The data section offers detailed definitions of the variables (e.g., Compustat data item information).

earnings variability to R&D that would lead them to conclude whether R&D capitalization should be permitted.

In most of the empirical analysis, we augment model (5) to include advertising expense as an explanatory variable. The motivation is that advertising costs represent an economically important outlay as seen from the descriptive statistics in the next section and because advertising is deemed to be an investment in an intangible asset. Advertising costs thus are expected to explain future earnings variability. This would mitigate the standard error of the coefficient estimates from model (5) and also reduce the correlated-omitted variable bias.

Leverage and size as control variables. The regression model (5) includes financial leverage and market value of equity as economic determinants of earnings variability. Finance theory predicts that, other things equal, earnings variability increases in financial leverage (see Beaver, Kettler, and Scholes, 1970, and White, Sondhi, and Fried, 1994, pp. 987-991, for theory and evidence).⁷ Earnings variability is expected to decrease in firm size for at least two reasons. First, small firms are more likely to be single-project or less diversified firms whereas large firms are expected to have multiple projects, divisions, or operating segments. To the extent operating earnings from the projects, divisions, or segments are less than perfectly correlated, diversification leads to a less volatile earnings stream for the large firms than small firms.

Second, Beaver, Kettler, and Scholes (1970) and others show that earnings variability and a market measure of risk, the CAPM beta, are positively correlated. We use size instead of beta as a determinant of earnings variability. There exists compelling evidence that firm size is at least as good as, and frequently better than, an historical estimate of beta as a measure of equity risk (e.g., Banz, 1981, Fama and French, 1992, and Kothari, Shanken, and Sloan, 1995). Empirically an historical estimate of beta is a noisy proxy for risk because (1) there is sampling error in a regression estimate, and (2) an historical beta, typically estimated using past five years

⁷ If interest charges are fixed, then the variability of earnings before and after interest charges would be identical, which means leverage will not affect earnings variability. However, empirically we find a strong relation.

of monthly returns, often reflects stale, not current, economic conditions affecting the firm's beta. In addition, beta estimation requires imposing additional data availability (typically, five years) for a firm to be included in the analysis. This would imply a continuous data availability requirement for 10 years (five years to estimate beta and five years to estimate future earnings variability) for a security to be included in the analysis. Overall, we believe that, when market capitalization is included as an independent variable, the incremental benefit of including a highly correlated variable like the historical beta estimate is small, if any.

Additional control variables. In addition to size and leverage, we summarize findings when the model also includes industry membership as a determinant of earnings variability and controls for the effect of earnings growth on earnings variability. If R&D investments are simply a proxy for industry membership that is driving the variability of future earnings then, in the absence of a control for industry membership, the sensitivity of earnings variability to R&D would be biased upward. A control for earnings growth makes sense for the following reason. R&D intensive firms are often high growth and investment opportunity firms. Their R&D success produces high positive earnings growth and failure might translate into high negative earnings growth. Suppose both are predictable. In this case, even though there is not a high degree of uncertainty about future benefits, the estimated standard deviation of future earnings will be high because of earnings growth. De-trending the time series of earnings and/or using first differences in earnings are two means of controlling the effect of growth on standard deviation. We undertake both the methods to mitigate the potential upward bias due to growth in the estimated relation between R&D and uncertainty of future benefits.

As we increase the number of controls, the marginal benefit of an additional control diminishes rapidly because most of the control variables are highly correlated with each other. Moreover, there is also a danger that we might potentially remove the treatment effect of R&D and capital expenditures on earnings variability, which is the main objective of this study. This appears to be the case when we include stock-return variability as a control variable. Stock

return variability reflects the market's assessment of a firm's cash flow uncertainty and therefore it in itself is a market-based measure of risk and earnings variability (see Beaver et al., 1970, for theory and evidence). When we include stock return variability in regression model (5), the coefficient on R&D remains significant and the point estimate is almost 50% greater than that on capital expenditures. However, the difference between the coefficients on R&D and capital expenditures is no longer statistically significant at 5% level.

Future years' earnings data availability. Since model (5) regresses future earnings variability on current investments, in order to calculate earnings variability, several future years' observations are needed. This data requirement is not innocuous in testing our hypothesis. Firms making risky R&D investments are more likely to experience extreme performance and thus experience financial distress. Therefore, they might not survive the future five years. Mergers and acquisitions might also affect their survival rate. If non-surviving firms are excluded from the analysis, earnings variability calculated using earnings of *ex post* surviving, successful firms might not be an unbiased *ex ante* forecast of a firm's earnings variability. The realized earnings volatility of a surviving firm might understate the market's *ex ante* estimate of earnings volatility at time t . This is expected to bias the results against our hypothesis that R&D investments generate more variable future earnings than capital expenditures.

To maintain both surviving and non-surviving firms in our sample and thus mitigate a potential sample-selection bias, we adopt the following approach. We calculate Altman's (1968) Z-score as a proxy for a firm's financial health for all stocks at time t . We rank the firms according to their Z-scores and assign each observation a decile rank. Next, we calculate earnings variability for each firm with data available for five years beyond year t . We then calculate the average earnings variability for each Z-score decile. We assign the mean earnings variability of the Z-score decile to which a firm with missing future earnings data belongs. For example, if a firm is delisted in year $t+3$ and belonged to Z-score decile two at time t , then it is assigned the mean earnings variability of all the decile two Z-score firms for which earnings

variability can be calculated. This approach likely mitigates the bias in estimated earnings variability that arises if data only on surviving firms are used.⁸ However, as it turns out the tenor of the results is unchanged whether or not we exclude non-surviving firms from the analysis.

IV. SAMPLE SELECTION, DATA, AND DESCRIPTIVE STATISTICS

We obtain financial data from the 1997 Compustat Annual Industrial and Annual Research files for the period 1972-1997. For each year t from 1972 to 1992, we retain all observations with non-missing data for the following:

$CapEx_t$ is capital expenditures, Compustat data #128,

$R\&D_t$ is research and development expense, data #46, with a zero reported amount not treated as a missing value,

$AdvEx_t$ is advertising expenditures, data #45, with a zero reported amount not treated as a missing value,

MV_t is the market value of equity, measured as the natural logarithm of the product of the fiscal-year closing price and common shares outstanding [$\log(\text{data \#199} * \text{data \#54})$],

$Leverage_t$ is the sum of long-term debt, data #9, and debt in current liabilities, data #34, divided by the sum of long-term debt and the market value of equity,

E_t is primary earnings per share before extraordinary items and discontinued operations, data #58,

P is share price, data #199, and

BVE is the stockholders' equity, data #216, divided by the number of common shares outstanding, and we exclude negative BE firms when BE is used as the deflator.

For all the variables except P and BVE , the values are for fiscal year t or at the end of fiscal year t . In contrast, P and BVE are measured at the end of fiscal year $t-1$ because they are used as deflators. Per share values of P , BVE , and future earnings, E_{t+1} to E_{t+5} , are adjusted for stock splits and stock dividends using the cumulative adjustment factor, Compustat data #27, so that they are comparable to the per share values of the remaining variables for year t . Since

⁸ We recognize that the survivor bias problem is not entirely circumvented. The decile portfolio average earnings variability is after all calculated using data for surviving firms only.

earnings variability is calculated using data for five years following year t , the last year of the sample period is 1992. The earliest year is set at 1972 because prior to that year relatively few firms on Compustat report information on R&D outlays.

Even though earnings variability is calculated using five years of future earnings data, to avoid survivor bias, we do not require earnings data availability for years $t+1$ to $t+5$ for a firm-year to be included in the data. As described in the previous section, in cases where earnings data are missing in any of the periods from $t+1$ through $t+5$, the standard deviation of earnings, $SD(E_{t+1,t+5})$ is set equal to the mean of $SD(E_{t+1,t+5})$ for the firms in the same Altman ZScore decile portfolio.

The sample-selection criteria yield a total of 55,073 firm-year observations when book value of equity is used as the deflator and 52,046 observations using price as the deflator. The use of deflated variables mitigates heteroscedasticity in the regressions. Since no single deflator is likely to be perfect in controlling heteroscedasticity, we report results using both BVE and price as deflators. The results are robust to deflator choice.

The number of non-missing firm-year observations on advertising expense is lower at 42,776 using book value as the deflator and at 40,569 using price as the deflator. We report regression results later in the paper with and without advertising expense as an independent variable to permit the use of the larger sample with R&D and capital expenditure data and to ascertain whether results are sensitive to the inclusion of advertising expenditures. Using book value of equity as the deflator, the number of observations each year ranges from a minimum of 2,003 in 1972 to a maximum of 2,899 in 1992. Using price as the deflator, the numbers range from a minimum of 1,909 in 1972 to a maximum of 2,680 in 1988. The number of firm-year observations with one or more of the future years' data missing is 16,107 using book value as the deflator and 15,733 using price as the deflator.

Descriptive statistics. Table 1, panel A reports descriptive statistics for variables deflated by the beginning of the period book value of equity, BVE, and panel B for variables deflated by

the beginning of the period price, P . MV and Leverage variables are not deflated. To mitigate the impact of outliers on regression coefficients, we winsorize $CapEx_t$, $R\&D_t$, $AdvEx_t$, MV_t , and $Leverage_t$ variables by setting the values in the bottom and top one percentiles to the highest values of the 1st and 99th percentiles. We winsorize observations with deflated E_t values of less than -1 or greater than 1 at -1 and +1.

Average outlays for capital expenditures, R&D, and advertising are substantial. Firms on average spend 19.8% of the book value of equity on capital expenditures and the corresponding expenditures on R&D and advertising are 10.8% and 5.7%. The averages, however, exceed the median capital expenditures, R&D, and advertising, which are 7.1%, 1.1%, and 0.8% of the book value of equity. Moreover, more than a fourth of the sample firms do not report any spending on advertising or R&D. These firms either did not incur such expenditures or they bundled them with other expenses for reasons of materiality. The distributions of capital expenditures, R&D, and advertising are all highly right skewed. This is likely due to the existence of a few high-growth, high-tech firms that invest heavily in capital assets and/or R&D. It might also result from a low denominator (P and/or BVE) that is often encountered in relatively young firms.

[Table 1]

The average standard deviation of earnings deflated by the book value of equity is 11.5% and it is 10% using share price as the deflator. Both the distributions are only moderately right skewed. Based on the average standard deviation magnitudes, publicly traded corporations' earnings vary considerably through time.

Univariate cross-correlations. Table 2, panels A and B report 21-year averages of the annual cross-sectional Pearson correlation coefficients among size, leverage, and the remaining variables, which are scaled by the book value of equity or share price. The pattern of correlations is unaffected by the choice of the scaling variable. In both panels A and B, all the correlations are statistically significant at the 1% level. We infer significance from a t-test on the mean of the 21 annual cross-correlations estimated for each pair of variables. In calculating the t-

test, we assume the 21 estimated annual cross-correlations are mutually uncorrelated. The positive correlations among firms' R&D and capital expenditures, and advertising are consistent with these investments being complements, not substitutes, in a typical firm's operations. Because of non-zero cross-correlations among various investment and control variables, these variables' univariate correlations with future earnings variability cannot be unambiguously interpreted as these investments' marginal effects on earnings variability. Nevertheless, we find that earnings variability is positively correlated with R&D, capital expenditures, and advertising. This is also consistent with growth, as proxied for by investments, being positively correlated with earnings variability, which is a measure of cash flow uncertainty.

[Table 2]

V. EMPIRICAL RESULTS

This section reports results of annual cross-sectional regressions of future earnings variability on current capital expenditures, R&D expenditures, advertising expense, and control variables, firm size and leverage [see equation (5) in section 2]. We report results using four measures of earnings variability. We estimate earnings variability using either earnings level or earnings change deflated by either book value of equity or share price. We report regression results with and without certain independent variables. For each regression specification, we report sample statistics of the 21 intercept and slope coefficient estimates. The t -statistic is calculated using the sample mean and standard deviation of the sample of 21 annual coefficient estimates. The standard deviation of the sample of 21 estimates, however, is likely to understate the true standard deviation because these estimates are not independent. The likely source of dependence is twofold.

First, we calculate the standard deviation of future earnings using a five-year rolling window, so that successive annual estimates of earnings variability (the dependent variable in the regression) are serially correlated. A portion of this serial dependence might persist in the regression residuals. In that case successive cross-sections of the annual regression residuals

would be correlated and so the coefficient estimates would also be correlated through time. Second, even apart from dependence due to the use of overlapping earnings data, true earnings variability itself is likely highly positively autocorrelated. Earnings variability is a risk characteristic and firms' risk characteristics generally are positively serially correlated. For example, risks of the firms in the gas and electric utility industry have been low for long periods and high technology, high growth firms tend to be risky year after year.

To incorporate the effect of serial correlation in the estimated coefficients on the standard error of the mean of the 21 annual coefficients, we report results using standard errors adjusted for the dependence using the Newey and West (1987) procedure. We correct for serial dependence in the coefficients by estimating autocorrelations up to five lags. The choice of five lags is logical because we use a five-year overlapping window to estimate earnings variability and also because empirically we find that autocorrelations beyond the fifth lag are fairly small. In addition, since we have only 21 annual observations, adjustment for dependence beyond five lags is not warranted (see Andrews, 1991 and Newey and West, 1994). In any case, the tenor of our results is unchanged upon using standard errors corrected for autocorrelations for greater or fewer than five lags.

Regression results

Table 3 reports the main results of the paper. Panel A reports results using the standard deviation of future earnings as the earnings variability measure and the book value of equity as the deflator for the dependent variable and all the independent variables except MV and Leverage. The average coefficient on R&D is 0.067 (t-statistic of 3.41). Each of the 21 annual regression coefficient estimates on R&D is positive and the median, 0.052, is close to the mean, which suggests the distribution of coefficients is not particularly right skewed. The average coefficient on capital expenditures is only 0.021 (t-statistic = 3.47) or less than one-third as large as the average coefficient on R&D. A t-test of the difference in means indicates that the average coefficient on R&D is statistically significantly greater than that on capital expenditures at a p-

value less than 0.01.⁹ The evidence is consistent with R&D investments generating significantly more uncertain future earnings than investments in capital assets.

[Table 3]

Economic significance. To gauge the economic significance of the increment to earnings variability due to R&D versus capital expenditures, we conduct the following thought experiment. Assume the average firm shifts all of its capital expenditures to R&D. Descriptive statistics in table 1 indicate that this would increase R&D expenditures annually by 19.8% of the firm's book value of equity. If an R&D expenditure is assumed to generate benefits for five years, then the incremental impact on earnings variability will be due to five years' incremental R&D expenditures equal to $5 \times 19.8\% = 99\%$ of the book value of equity. Since the coefficient on R&D is 0.067 compared to 0.021, the incremental standard deviation of earnings is expected to be $(0.067 - 0.021) \times 99\% = 4.55\%$ of book value of equity.¹⁰ The average firm's standard deviation of earnings as reported in table 1 is 11.5%. Therefore, the 4.55% increase in earnings variability represents a 39.6% increase in the standard deviation of earnings or a 95% increase in the variance of earnings ($= 1.396^2 - 1$). This represents an economically large impact of R&D on earnings variability relative to the effect of capital expenditures. We discuss below corresponding numbers using price as the deflator regression results in panel B and using hypothetically capitalized values of R&D and actual property, plant, and equipment assets as

⁹ The t-statistic that we calculate accounts for the dependence in the time series of estimated coefficients on R&D and capital expenditures. To estimate the dependence, we correlate the time series of estimated coefficients on R&D with the coefficients on capital expenditures. The estimated correlation is positive when book value is the deflator and negative when price is the deflator. This correlation is used in adjusting the standard error of the difference in the means of the coefficients on R&D and capital expenditures. If the t-test were to ignore this dependence, the standard error of the difference in the coefficients is too large when the dependence is positive and too small when the dependence is negative.

¹⁰ Our use of the coefficients from the regressions in table 3 according to equation (3) might overstate the impact of R&D on earnings variability if R&D expenditures are serially correlated (see discussion earlier in the context of equations (3) and (4)). We control for this potential bias by estimating a regression according to equation (4) in table 4.

reported on the balance sheet (table 4). In all cases, the results suggest an economically important impact of R&D expenditures on earnings variability.

Discussion of other results in table 3. Results in panel A of table 3 also reveal that the average coefficient on advertising expense, 0.025 (t-statistic = 8.52) is approximately of the same magnitude as that on capital expenditures, but much smaller than that on R&D. There are at least two explanations consistent with this result. First, benefits from advertising are about as uncertain as those from capital expenditures, perhaps because most corporate advertising is about products that corporations have already introduced in the market.

Second, advertising yields fairly short-lived future benefits. Clarke (1976, p. 355) concludes that “advertising’s effect on sales lasts for months rather than years is strongly supported.” Batra, Myers, and Aaker (1996, p. 567) in a popular textbook on advertising management also conclude that “the immediate and carryover effect of advertising usually occurs in months, not years.” A similar inference can be drawn from Assmus, Farley, and Lehmann (1984, table 1). Lodish et al. (1996) perform a statistical analysis summarizing the findings in 389 academic research studies on the effect of advertising on sales. Somewhat surprisingly to us, their analysis suggests “no obvious relationship” between advertising and sales. On average the sensitivity of sales to advertising is statistically significantly greater than zero, but economically modest (see Lodish et al., 1996, pp. 128-129 and table 3). The short-lived nature of the benefits from advertising is relevant to interpreting the coefficient on advertising in our regression model. Recall that the simulations demonstrate that, other things equal, the shorter the future period of benefits from current investments, the smaller the sensitivity of earnings variability to that investment.

The regressions in panel A of table 3 include two control variables; the natural logarithm of the market value of equity and leverage (defined as the ratio of the book value of long-term debt to the sum of the market value of equity and long-term debt). The average coefficients on

both the variables are highly significant and have predicted signs. Earnings variability declines in firm size and it increases in leverage.

Results using price as the deflator. Results in panel B of table 3 use earnings variability measured as the standard deviation of earnings scaled by the beginning of the period price. The results are similar to those in panel A using the book value of equity as the deflator. The implied increase in the standard deviation (variance) of earnings by shifting all capital expenditures to R&D is 28.2% (64.4%), which strikes us as economically substantial. The average coefficient magnitudes on all the variables are slightly larger than, but similar in their pattern to, those in panel A. In contrast, the t -statistics are considerably higher on R&D, capital expenditure and leverage, implying the coefficients are estimated more precisely. The lower standard errors are a result of a narrower range in the coefficient estimates, as seen from the minimum and maximum values of the coefficient estimates, and a smaller Newey-West adjustment for dependence in the coefficient estimates compared to that in panel A. Price deflation appears to reduce the degree of serial correlation in the residuals and therefore also in the coefficient estimates. The t -statistic for the difference between the mean coefficients on R&D and capital expenditures is 4.83 with a p -value of less than 0.01.

We find that the similarity in the results using the book value of equity and price as deflators is also observed in all of the tests we discuss below. Since reporting the results using both the deflators yield no new insight, in the rest of the paper we only present results using the book value of equity as the deflator. Interested readers can obtain results using price as the deflator from us.

Capitalizing R&D and earnings without depreciation and expensing of R&D. We next discuss results with two important modifications in variable measurement. First, we estimate the capitalized value of R&D assets and use those as well as the capitalized values of property, plant, and equipment in the earnings variability regressions. Second, we estimate earnings variability using earnings with depreciation and R&D expenditures added back.

Capitalizing R&D. Preceding results measure the marginal impact of a single period's R&D and capital expenditures on earnings variability according to equation (3). However, earnings are a result of cumulative investments. An important advantage of estimating the sensitivity of earnings variability to capitalized values of R&D is that the bias in the estimated sensitivity in a regression according to equation (3) is mitigated. As discussed before, the bias arises when R&D expenditures are serially correlated. A disadvantage of using capitalized values of R&D is that a researcher must estimate it using historical data, which imposes additional data availability requirements and in our case the sample size declines by almost 50%.

As suggested by equation (4), the impact of cumulative investment on earnings variability can be estimated by regressing earnings variability on cumulative investment in R&D and capital expenditures. One measure of the cumulative investment of capital expenditure is the net carrying value of property, plant, and equipment on the balance sheet. Because R&D is expensed, a corresponding value for R&D is not available. We estimate R&D assets in year t as the sum of R&D expenditures for the past years, each depreciated at the rate of 20% per years (i.e, assuming straight line depreciation over five years).¹¹ Thus, we use a hypothetical capitalized R&D estimate. Panel A of table 4 shows that average property, plant and equipment as a percentage of the book value of equity is 60.8% compared to our estimate of 26.4% for capitalized R&D over the book value of equity.

[Table 4]

Gross earnings. U.S. GAAP earnings in period t are net of R&D expenditures incurred in period t but not net of capital expenditures incurred in period t . Instead, only a fraction of past capital expenditures is deducted as depreciation in calculating earnings. It is possible that annual earnings of periods $t+1$ to $t+5$ are more variable simply because of variation in these periods' R&D outlays and therefore the results in table 3 might be a mechanical consequence of the

¹¹ The use of a researcher's estimate of the capitalized R&D asset is a drawback of attempting to measure the sensitivity of earnings variability to R&D. A researcher must make simplifying assumptions like all R&D assets have the same useful life and same depreciation schedule.

accounting treatment of R&D expenditures. Compared to R&D, depreciation expense is less likely to impart large variability in future earnings because only a fraction of the average capital expenditure over past several years is deducted in calculating earnings. That is, the time series of depreciation expense is relatively smooth.

To control for the potential variability in future earnings induced by the accounting treatment of R&D, we gross up future earnings by adding back both future R&D and depreciation. The resulting numbers represent future benefits of current and past R&D and capital expenditures and are less influenced by future R&D and capital expenditures. However, descriptive statistics in panel A of table 4 show that grossing up future earnings by adding back depreciation and R&D has only a small effect on earnings variability. The average standard deviation as a percentage of equity increases to 11.7% in table 4 compared to 11.5% as reported in table 1 using GAAP earnings. The corresponding numbers for price deflated variables are 10.6% and 10.0%.

Panel B of table 4 reports regression results similar to those in table 3. Capitalized R&D maps into earnings variability with a coefficient of 0.041 (t-statistic = 3.71) compared to 0.009 (t-statistic = 4.54). To gauge the economic significance, we estimate the marginal impact of shifting all capital expenditures to R&D. For the average firm, such a shift will increase the standard deviation of earnings by 16.6% ($= 0.608 \times (0.041 - 0.009) / 0.117$) or earnings variance by 35.9%. The corresponding increases using price as the deflator are 27.9% and 63.6%. Thus, once again, R&D expenditures appear to contribute significantly to earnings variability compared to capital expenditures.

Results excluding zero R&D observations. We observe from the sample descriptive statistics that more than a fourth of the sample firm-year observations report zero R&D expense, probably because their R&D outlays are not a material expense to be reported as a separate line item. A concentration of a large fraction of observations with a zero value for the independent variable (R&D) might potentially bias upwards the slope coefficient on the independent variable.

We therefore report regression results similar to those in table 3 except that we now exclude all firm-year observations with zero R&D expense. The results reported in table 5 reveal little change relative to those in table 3. The average coefficient on R&D is 0.069 (t-statistic = 3.28), which is more than three times the average coefficient on capital expenditures, 0.018 (t-statistic = 3.04). Once again, the difference is statistically significant at the 1% level of significance. The implied increase in the standard deviation (variance) of earnings by shifting all capital expenditures to R&D is a hefty 43.9% (107%).

[Table 5]

Results excluding advertising expense. We next discuss regression results for the model that excludes advertising expense as one of the independent variables. The motivation is that data for advertising expense is reported considerably less frequently than for R&D and capital expenditures (see descriptive statistics in table 1). Table 6 shows that the tenor of the results is unaffected when a larger sample without requiring data for advertising is analyzed. The average coefficient on R&D is 0.072 (t-statistic = 3.21) compared to the average coefficient of 0.024 (t-statistic = 3.83) on capital expenditures. Switching all capital expenditures to R&D will increase the earnings standard deviation by 41.3%.

[Table 6]

Robustness checks

We perform many tests to ascertain whether our results are sensitive to alternative research design choices and variable definitions. We begin by describing results using the standard deviation of change in earnings as a measure of earnings variability. We then summarize results of the tests that include a control for industry effects and growth, an analysis with a symmetric treatment of both capital expenditures and R&D expenditures in calculating future earnings (benefits), pooled data analysis, and other robustness checks. In every single case the results are similar to those described so far in the paper.

Results using standard deviation of the change in earnings as the variability measure.

So far we have reported regression results using the standard deviation of the earnings level deflated by the book value of equity or price as the earnings variability measure. While we believe that variability in deflated earnings is an economically sensible measure, an equally sensible alternative measure is the standard deviation of the change in earnings deflated by the book value of equity or share price. If the time series properties of earnings suggest they are largely permanent, then the standard deviation of earnings changes is likely a better measure of earnings variability, whereas if considerably temporary components of earnings are non-trivial, then the standard deviation of earnings levels would be a better measure of earnings variability. Since earnings contain both permanent and transitory components and because previous research documents both cross-sectional and temporal variation in these components, the standard deviation of neither the level nor the change in earnings is unambiguously a superior measure of earnings variability. One advantage of using the standard deviation of earnings changes is that if there is substantial growth (or decline) in earnings over the estimation period, then the standard deviation of first differences is largely unaffected by growth. In contrast, *ceteris paribus*, the standard deviation of the earnings level is increasing in absolute growth. To control for this effect on the standard deviation of earnings, either an explicit control for growth is needed or the earnings series should be detrended.¹² Empirically we find the standard deviation of earnings levels and differences to be highly correlated in our sample.

Table 7 shows that results using the variability of deflated change in earnings more strongly favor the hypothesis that R&D investments produce future benefits that are more

¹² As an alternative to earnings changes as a means of controlling for growth, we calculate future earnings net of *ex post* earnings growth over the estimation period (five years). We regress future earnings on time to capture growth and reestimate the standard deviation using earnings minus average realized growth for each firm. Regression analysis using the standard deviation of growth-adjusted earnings, deflated by the book value, yields an average coefficient of 0.052 (t-statistic = 3.34) on R&D and 0.015 (t-statistic = 3.22) on capital expenditures, with the difference between the two average coefficients being significant at a p-value of 0.01.

uncertain than those from capital expenditures. The average explanatory power of the regression model is similar to that reported in the previous tables.

[Table 7]

Control for industry effects. We begin by providing descriptive evidence on the average investment in R&D and capital expenditures and the standard deviation of earnings by two-digit SIC code industries in table 8. The table presents industries in ascending order of industry median R&D investment. The descriptive statistics are striking in that there is little variation in earnings variability across industries, whereas both capital expenditures and R&D exhibit substantial cross-industry variation. This is consistent with firms' choices of other determinants of earnings variability being such that univariate industry analysis is ineffective in teasing out R&D's contribution to earnings variability. The descriptive statistics also reveal that there is considerable within industry variation in both investment intensities and earnings variability, which might explain the relation between investments and earnings uncertainty. Therefore, industry membership by itself does not seem to drive the relation between R&D and earnings variability seen earlier. A formal test to examine this issue follows.

[Table 8]

We augment regression model (1) to include industry dummies. Industry dummies control for the variation in the level of earnings variability across industries. Without industry dummies, it is possible that we document a positive relation between earnings variability and R&D intensity that is due to industry membership rather than such a relation due to variation in R&D intensity both within and across industries. The inclusion of industry dummies in the regression model, however, does not change the result that R&D expenditures influence earnings variability more so than capital expenditures. The average coefficient is 0.071 (t-stat = 6.11) on R&D, 0.027 (t-stat = 6.27) on capital expenditures, and 0.044 (t-stat = 8.06) on advertising expense. The average coefficient on R&D significantly exceeds that on capital expenditures at the 1% significance level.

Pooled cross-sectional analysis. We estimate a pooled time-series cross-sectional regression instead of annual cross-sectional regressions. Once again, the results are similar to those reported earlier. For example, using price as the deflator, the coefficient on R&D is 0.067 (t-statistic = 20.08) and that on capital expenditures is 0.020 (t-statistic = 12.31).

Other robustness checks. First, we examine the effect that replacing firms' missing values of earnings variability with the mean earnings variability of their respective Z-score decile portfolios has on the results. Recall that we substitute decile portfolio mean earnings variability in approximately a third of the sample. Both pooled regression results and annual cross-sectional regression results reveal that the exclusion of missing earnings variability observations does not alter the tenor of the results.

Second, instead of winsorizing the extreme 1% observations, which might have an undue influence on the estimated coefficients, we repeat the regression analysis using data that excludes the extreme 1% observations. There is no material effect on the results. Finally, we repeat the entire analysis using variance instead of the standard deviation as a measure of future earnings' variability, which has no impact on our inferences.

VI. SUMMARY AND CONCLUSIONS

The FASB's statement of Financial Accounting Concepts No. 2 notes that the trade-off between relevance and uncertainty of future benefits is a major consideration in accounting standard setting with respect to capitalization and expensing of investment expenditures. The trade-off suggests balancing the demand for value-relevant information by equity investors, with the demand for reliable information about future benefits, by debt holders and other contracting parties. However, much of the current research on accounting for R&D expenditures focuses on the relevance dimension of this tradeoff (e.g., Dukes, Dyckman, and Elliott, 1980, Horwitz and Kolodny, 1980, Elliott, Richardson, Dyckman, and Dukes, 1984, and Wasley and Linsmeier, 1992). To compliment existing research, we examine the reliability of future benefits of R&D expenditures relative to other investments such as capital expenditures.

Our analysis compares the relative contributions of current investments in R&D and capital expenditures to future earnings variability. We use the standard deviation of future earnings to proxy for future earnings variability. Our sample consists of over 50,000 firm-year observations, obtained from Compustat's Annual Industrial and Research files, from 1972-1992. Our results support the hypothesis that R&D investments generate more uncertain future benefits compared to capital expenditures. Controlling for other economic determinants of earnings variability, we find that the coefficient on current R&D expenditures is about three times that of the coefficient on current capital expenditures. This difference is statistically significant. Our results are robust to many sensitivity checks, including controls for industry effects and growth, alternative variable definitions, and research design variations.

We believe that our study contributes to the current debate over accounting for R&D expenditures. A number of studies report convincing evidence that the capitalization of R&D would aid in making the balance sheet more value relevant for share prices (e.g., Lev and Sougiannis, 1996). These studies provide standard setters with useful information on the relevance dimension of the relevance-reliability tradeoff. Our study provides evidence that the future benefits of R&D expenditures are less certain than those of investments in capital expenditures. Hence, we provide standard setters with a relative measure of the reliability of future benefits component of the relevance-reliability trade-off.

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TABLE 1
Descriptive Statistics

Panel A- Scaled by Book Value of Equity Per Share

Variable	Description	N	Mean	Standard					
				Deviation	Min	q1	Median	q3	Max
$R\&D_t$	R&D Expense	55,073	0.108	0.477	0.000	0.000	0.011	0.064	12.694
$CapEx_t$	Capital Expenditures	55,073	0.198	0.577	0.000	0.027	0.071	0.162	13.561
$AdvEx_t$	Advertising Expense	42,776	0.057	0.168	0.000	0.000	0.008	0.045	5.068
MV_t	Log Market Value	55,073	-3.19	2.02	-8.13	-4.68	-3.42	-1.86	3.18
$Leverage_t$	Leverage (Debt/MV+Debt)	55,073	0.289	0.243	0.000	0.070	0.241	0.463	0.955
E_t	EPS	55,073	0.061	0.278	-1.000	0.013	0.106	0.181	1.000
$Var(E_{t+1,t+5})$	Variance of Earnings	55,073	0.028	0.051	0.000	0.002	0.012	0.031	0.512
$SD(E_{t+1,t+5})$	Standard Deviation of Earnings	55,073	0.115	0.095	0.000	0.049	0.097	0.139	0.715

Panel B- Scaled by Price

Variable	Description	N	Mean	Standard					
				Deviation	Min	q1	Median	q3	Max
$R\&D_t$	R&D Expense	52,046	0.045	0.125	0.000	0.000	0.007	0.040	3.382
$CapEx_t$	Capital Expenditures	52,046	0.128	0.261	0.000	0.017	0.051	0.133	6.486
$AdvEx_t$	Advertising Expense	40,569	0.043	0.108	0.000	0.000	0.004	0.033	1.513
MV_t	Log Market Value	52,046	-3.142	2.028	-8.131	-4.637	-3.377	-1.798	3.185
$Leverage_t$	Leverage (Debt/MV+Debt)	52,046	0.294	0.242	0.000	0.078	0.249	0.469	0.955
E_t	EPS	52,046	0.052	0.212	-1.000	0.011	0.074	0.137	1.000
$Var(E_{t+1,t+5})$	Variance of Earnings	52,046	0.024	0.046	0.000	0.002	0.011	0.025	0.512
$SD(E_{t+1,t+5})$	Standard Deviation of Earnings	52,046	0.100	0.089	0.000	0.041	0.085	0.119	0.614

The full sample consists of all firms on the Compustat Annual Industrial and Industrial Research files from 1972-1992 for which $CapEx_t$, $R\&D_t$, MV_t and $Leverage_t$ are available. Each of the following variables except MV_t and $Leverage_t$ is deflated by either the book value of equity per share (panel A) or the stock price (panel B), at the end of the fiscal year $t-1$.

$R\&D_t$ is R&D expense per share;

$CapEx_t$ is capital expenditures per share;

$AdvEx_t$ is advertising expense per share;

MV_t is the natural log of the Market Value at the end of fiscal year t ;

$Leverage_t$ is the book value of debt divided by debt plus the market value of equity both at the end of fiscal year t ;

E_t is earnings per share;

$SD(E_{t+1,t+5})$ is the standard deviation of earnings per share before extraordinary items and discontinued operations; the standard deviation is calculated using five annual earnings observations for years $t+1$ through $t+5$.

Variables are winsorized by setting the values in the 1st and 100th percentiles to the minimum and maximum values in the 2nd and 99th percentiles. Observations with deflated EPS values of less than -1 or greater than 1 are winsorized at -1 and +1. In cases where EPS data are absent in any of the years from $t+1$ through $t+5$, $SD(E_{t+1,t+5})$ is set equal to the mean $SD(E_{t+1,t+5})$ of the firms in the same Altman Z-Score decile portfolio (see section 2 for details).

TABLE 2
Mean Correlations Among Independent Variables

Panel A: Pearson Correlation Coefficients - Variables Scaled By Book Value of Equity Per Share							
Variable	Description	$R\&D_t$	$CapEx_t$	$AdvEx_t$	MV_t	$Leverage_t$	$SD(E_{t+1,t+5})$
$R\&D_t$	R&D Expense	1.000					
$CapEx_t$	Capital Expenditures	0.266	1.000				
$AdvEx_t$	Advertising Expense	0.218	0.257	1.000			
MV_t	Log Market Value	-0.081	-0.068	-0.093	1.000		
$Leverage_t$	Leverage	-0.073	0.087	0.061	-0.173	1.000	
$SD(E_{t+1,t+5})$	Standard Deviation - Earnings	0.166	0.158	0.111	-0.247	0.095	1.000

Panel B: Pearson Correlation Coefficients - Variables Scaled By Price							
Variable	Description	$R\&D_t$	$CapEx_t$	$AdvEx_t$	MV_t	$Leverage_t$	$SD(E_{t+1,t+5})$
$R\&D_t$	R&D Expense	1.000					
$CapEx_t$	Capital Expenditures	0.253	1.000				
$AdvEx_t$	Advertising Expense	0.179	0.268	1.000			
MV_t	Log Market Value (Billions)	-0.120	-0.117	-0.153	1.000		
$Leverage_t$	Leverage	0.049	0.284	0.193	-0.173	1.000	
$SD(E_{t+1,t+5})$	Standard Deviation - Earnings	0.140	0.195	0.150	-0.298	0.285	1.000

Above are the means of annual Pearson correlations from 1972-1992. Each of the following variables except MV_t and $Leverage_t$ is deflated by either the book value of equity per share (panel A) or the stock price (panel B), at the end of the fiscal year $t-1$.

$SD(E_{t+1,t+5})$ is the standard deviation of earnings per share before extraordinary items and discontinued operations; the standard deviation is calculated using five annual earnings observations for years $t+1$ through $t+5$;

$R\&D_t$ is R&D expense per share;

$CapEx_t$ is capital expenditures per share;

$AdvEx_t$ is advertising expense per share;

MV_t is the natural log of the Market Value at the end of fiscal year t ;

$Leverage_t$ is the book value of debt divided by debt plus the market value of equity both at the end of fiscal year t .

We obtain data from the Compustat Annual Industrial and Research files. We winsorize all variables by setting the values in the 1st and 100th percentiles to the minimum and maximum values in the 2nd and 99th percentiles. Observations with deflated EPS values of less than -1 or greater than 1 are winsorized at -1 and +1. In cases where EPS data are absent in any of the years from $t+1$ through $t+5$, $SD(E_{t+1,t+5})$ is set equal to the mean $SD(E_{t+1,t+5})$ of the firms in the same Altman Z-Score decile portfolio (see section 2 for details).

All the correlations are significant at the 0.01 level using a two-tailed test.

TABLE 3

Summary of 21 Annual Cross-Sectional Regressions From 1972-1992

$$SD(E_{t+1,t+5}) = a + b_{1t} R\&D_t + b_{2t} CapEx_t + b_{3t} AdvEx_t + b_{4t} MV_t + b_{5t} Leverage_t + error_{t+1,t+5}$$

Panel A: Scaled by Book Value of Equity Per Share

Variable	Description	Mean	t-stat	Standard Deviation	Min	q1	Median	q3	Max
Intercept	Intercept	0.068	6.40	0.024	0.030	0.046	0.072	0.087	0.108
R&D _t	R&D Expense	0.067	3.41	0.047	0.004	0.026	0.052	0.097	0.161
CapEx _t	Capital Expenditures	0.021	3.47	0.015	-0.001	0.011	0.015	0.034	0.055
AdvEx _t	Advertising Expense	0.025	8.52	0.014	0.002	0.014	0.027	0.034	0.051
MV _t	Log Market Value (Billions)	-0.010	-11.07	0.002	-0.013	-0.011	-0.010	-0.009	-0.006
Leverage _t	Debt/(Market Value+Debt)	0.025	5.19	0.016	-0.004	0.013	0.022	0.034	0.058
	Adjusted R ² in %	10.2		2.2	6.1	8.5	10.0	11.6	14.4

Panel B: Scaled by Price

Variable	Description	Mean	t-stat	Standard Deviation	Min	q1	Median	q3	Max
Intercept	Intercept	0.034	8.25	0.010	0.009	0.028	0.034	0.041	0.049
R&D _t	R&D Expense	0.072	6.34	0.039	0.003	0.038	0.070	0.100	0.140
CapEx _t	Capital Expenditures	0.028	9.00	0.016	0.004	0.021	0.026	0.035	0.061
AdvEx _t	Advertising Expense	0.030	3.81	0.023	-0.020	0.018	0.027	0.048	0.068
MV _t	Log Market Value (Billions)	-0.010	-12.94	0.002	-0.015	-0.012	-0.010	-0.009	-0.007
Leverage _t	Leverage	0.086	12.42	0.022	0.040	0.074	0.079	0.099	0.143
	Adjusted R ² in %	18.4		2.4	15.0	16.8	17.5	20.6	22.4

Each of the following variables except MV_t and Leverage is deflated by either the book value of equity per share (panel A) or the stock price (panel B), at the end of the fiscal year t-1.

SD(E_{t+1,t+5}) is the standard deviation of earnings per share before extraordinary items and discontinued operations; the standard deviation is calculated using five annual earnings observations for years t+1 through t+5;

R&D_t is R&D expense per share;

CapEx_t is capital expenditures per share;

AdvEx_t is advertising expense per share;

MV_t is the natural log of the Market Value at the end of fiscal year t;

Leverage_t is the book value of debt divided by debt plus the market value of equity both at the end of fiscal year t.

We obtain data from the Compustat Annual Industrial and Research files. The sample size is 42,776 in Panel A and 40,569 in panel B. We winsorize all variables by setting the values in the 1st and 100th percentiles to the minimum and maximum values in the 2nd and 99th percentiles. Observations with deflated EPS values of less than -1 or greater than 1 are winsorized at -1 and +1. In cases where EPS data are absent in any of the years from t+1 through t+5, SD(E_{t+1,t+5}) is set equal to the mean SD(E_{t+1,t+5}) of the firms in the same Altman Z-Score decile portfolio (see section 2 for details).

Reported t-tests are adjusted for autocorrelation using the Newey-West correction with 5 lags.

TABLE 4
Analysis With Capitalized R&D and Property, Plant and Equipment
 $SD(E_{t+1,t+5}) = a + b_{1t} CAPR\&D_t + b_{2t} PPE_t + b_{3t} AdvEx_t + b_{4t} MV_t + b_{5t} Leverage_t + error_{t+1,t+5}$

Panel A- Descriptive Statistics

Variable	Description	Standard						
		Mean	Deviation	Min	q1	Median	q3	Max
CAPR&D _t	R&D Capital	0.264	0.989	0.000	0.010	0.062	0.207	29.732
PPE _t	Net Property, Plant and Equipment	0.608	1.166	0.000	0.134	0.322	0.648	21.534
Var(E _{t+1,t+5})	Variance of Earnings	0.028	0.046	0.000	0.003	0.016	0.030	0.415
SD(E _{t+1,t+5})	Standard Deviation of Earnings	0.117	0.089	0.000	0.057	0.102	0.139	0.644

Panel B: Regression Results - Summary of 21 Annual Cross-Sectional Regressions From 1972-1992

Variable	Description	Mean	t-stat	Standard						
				Deviation	Min	q1	Median	q3	Max	
Intercept	Intercept	0.068	5.70	0.027	0.026	0.039	0.075	0.090	0.109	
CAPR&D _t	R&D Capital	0.041	3.71	0.031	0.005	0.015	0.036	0.057	0.114	
PPE _t	Net Property, Plant and Equipment	0.009	4.54	0.008	-0.001	0.005	0.008	0.012	0.031	
AdvEx _t	Advertising Expense	-0.009	-0.52	0.056	-0.177	-0.033	0.014	0.023	0.076	
MV _t	Log Market Value (Billions)	-0.007	-19.44	0.001	-0.010	-0.008	-0.007	-0.007	-0.004	
Leverage _t	Debt/(Market Value+Debt)	0.035	3.93	0.025	-0.011	0.016	0.033	0.059	0.081	
	Adjusted R ² in %	16.6		11.7	5.7	11.1	13.4	15.5	58.6	

The full sample consists of all firms on the Compustat Annual Industrial and Industrial Research files from 1972-1992 for which CapEx, R&D_t, MV_t and Leverage_t are available. Estimation of capitalized R&D requires five years of R&D expenditures, which reduces the sample size for this analysis from 55,073 to 29,408. Each of the following variables except MV_t and Leverage_t is deflated by the book value of equity per share at the end of the fiscal year t-1.

CAPR&D_t is the capitalized value of R&D per share. The capitalized value of R&D is estimated by amortizing R&D expenditures at a rate of 20% per year.

PPE_t is net Property, Plant and Equipment per share.

AdvEx_t is advertising expense per share.

MV_t is the natural log of the Market Value at the end of fiscal year t.

Leverage_t is the book value of debt divided by debt plus the market value of equity both at the end of fiscal year t.

E_t is earnings per share excluding R&D expense and depreciation expense.

SD(E_{t+1,t+5}) is the standard deviation of earnings per share before extraordinary items and discontinued operations. The standard deviation is calculated using five annual earnings observations for years t+1 through t+5.

Variables are winsorized by setting the values in the 1st and 100th percentiles to the minimum and maximum values in the 2nd and 99th percentiles. Observations with deflated EPS values of less than -1 or greater than 1 are winsorized at -1 and +1. In cases where EPS data are absent in any of the years from t+1 through t+5, SD(E_{t+1,t+5}) is set equal to the mean SD(E_{t+1,t+5}) of the firms in the same Altman Z-Score decile portfolio (see section 2 for details).

Reported t-tests are adjusted for autocorrelation using the Newey-West correction with 5 lags.

TABLE 5
Summary of 21 Annual Cross-Sectional Regressions From 1972-1992
All Observations Where R&D is Zero are Omitted

$$SD(E_{t+1,t+5}) = a + b_{1t} R\&D_t + b_{2t} CapEx_t + b_{3t} AdvEx_t + b_{4t} MV_t + b_{5t} Leverage_t + error_{t+1,t+5}$$

Variable	Description	Mean	t-stat	Standard Deviation	Min	q1	Median	q3	Max
Intercept	Intercept	0.067	5.77	0.026	0.027	0.041	0.072	0.089	0.111
R&D _t	R&D Expense	0.069	3.28	0.049	0.003	0.025	0.053	0.096	0.163
CapEx _t	Capital Expenditures	0.018	3.04	0.015	-0.003	0.007	0.014	0.032	0.053
AdvEx _t	Advertising Expense	0.030	6.75	0.020	0.001	0.013	0.030	0.040	0.072
MV _t	Log Market Value (Billions)	-0.010	-10.74	0.002	-0.014	-0.012	-0.010	-0.009	-0.006
Leverage _t	Debt/(Market Value+Debt)	0.027	8.98	0.012	0.001	0.017	0.026	0.038	0.046
	Adjusted R ² in %	11.0		2.0	6.7	10.1	10.8	11.9	14.8

Each of the following variables except MV_t and Leverage is deflated by the book value of equity per share, at the end of the fiscal year t-1.

SD(E_{t+1,t+5}) is the standard deviation of earnings per share before extraordinary items and discontinued operations; the standard deviation is calculated using five annual earnings observations for years t+1 through t+5;

R&D_t is R&D expense per share;

CapEx_t is capital expenditures per share;

AdvEx_t is advertising expense per share;

MV_t is the natural log of the Market Value at the end of fiscal year t;

Leverage_t is the book value of debt divided by debt plus the market value of equity both at the end of fiscal year t.

We obtain data from the Compustat Annual Industrial and Research files. All firm-year observations with a value of zero for R&D_t are omitted. The sample size is 35,772. We winsorize all variables by setting the values in the 1st and 100th percentiles to the minimum and maximum values in the 2nd and 99th percentiles. Observations with deflated EPS values of less than -1 or greater than 1 are winsorized at -1 and +1. In cases where EPS data are absent in any of the years from t+1 through t+5, SD(E_{t+1,t+5}) is set equal to the mean SD(E_{t+1,t+5}) of the firms in the same Altman Z-Score decile portfolio (see section 2 for details).

Reported t-tests are adjusted for autocorrelation using the Newey-West correction with 5 lags.

TABLE 6
Summary of 21 Annual Cross-Sectional Regressions From 1972-1992
Advertising Expense is Omitted

$$SD(E_{t+1,t+5}) = a + b_{1t} R\&D_t + b_{2t} CapEx_t + b_{3t} MV_t + b_{4t} Leverage_t + error_{t+1,t+5}$$

Variable	Description	Mean	t-stat	Standard Deviation	Min	q1	Median	q3	Max
Intercept	Intercept	0.068	6.42	0.024	0.031	0.044	0.073	0.087	0.110
R&D _t	R&D Expense	0.072	3.21	0.052	0.007	0.026	0.053	0.115	0.178
CapEx _t	Capital Expenditures	0.024	3.83	0.017	0.007	0.013	0.016	0.035	0.069
MV _t	Log Market Value (Billions)	-0.010	-9.92	0.002	-0.014	-0.011	-0.011	-0.008	-0.006
Leverage _t	Debt/(Market Value+Debt)	0.022	4.92	0.016	-0.007	0.012	0.016	0.034	0.055
	Adjusted R ² in %	10.1		1.9	6.5	8.6	10.2	11.4	14.0

Each of the following variables except MV_t and Leverage is deflated by the book value of equity per share at the end of the fiscal year t-1.

SD(E_{t+1,t+5}) is the standard deviation of earnings per share before extraordinary items and discontinued operations; the standard deviation is calculated using five annual earnings observations for years t+1 through t+5;

R&D_t is R&D expense per share;

CapEx_t is capital expenditures per share;

MV_t is the natural log of the Market Value at the end of fiscal year t;

Leverage_t is the book value of debt divided by debt plus the market value of equity both at the end of fiscal year t.

We obtain data from the Compustat Annual Industrial and Research files. The sample size is 55,073 in Panel A and 52,046 in panel B. We winsorize all variables by setting the values in the 1st and 100th percentiles to the minimum and maximum values in the 2nd and 99th percentiles. Observations with deflated EPS values of less than -1 or greater than 1 are winsorized at -1 and +1. In cases where EPS data are absent in any of the years from t+1 through t+5, SD(E_{t+1,t+5}) is set equal to the mean SD(E_{t+1,t+5}) of the firms in the same Altman Z-Score decile portfolio (see section 2 for details).

Reported t-tests are adjusted for autocorrelation using the Newey-West correction with 5 lags

TABLE 7
Summary of 21 Annual Cross-Sectional Regressions From 1972-1992
 $SD(DE_{t+1,t+5}) = a + b_{1t}R\&D_t + b_{2t}CapEx_t + b_{3t}AdvEx_t + b_{4t}MV_t + b_{5t}Leverage_t + error_{t+1,t+5}$

Variable	Description	Mean	t-stat	Standard Deviation	Min	q1	Median	q3	Max
Intercept	Intercept	0.091	6.62	0.031	0.043	0.064	0.096	0.114	0.149
R&D _t	R&D Expense	0.106	3.49	0.075	0.016	0.044	0.072	0.150	0.315
CapEx _t	Capital Expenditures	0.037	3.52	0.028	0.008	0.018	0.023	0.051	0.107
AdvEx _t	Advertising Expense	0.035	6.22	0.025	-0.011	0.017	0.034	0.047	0.094
MV _t	Log Market Value (Billions)	-0.013	-7.88	0.004	-0.018	-0.016	-0.013	-0.009	-0.007
Leverage _t	Debt/(Market Value+Debt)	0.021	3.45	0.022	-0.028	0.004	0.023	0.031	0.064
	Adjusted R ² in %	11.9		3.6	7.1	8.9	12.3	14.0	20.1

Each of the following variables except MV_t and Leverage_t is deflated by the book value of equity per share at the end of the fiscal year t-1.

SD($\Delta E_{t+1,t+5}$) is the standard deviation of the change in earnings per share before extraordinary items and discontinued operations; the standard deviation is calculated using five annual observations for years t+1 through t+5;

R&D_t is R&D expense per share;

CapEx_t is capital expenditures per share;

AdvEx_t is advertising expense per share;

MV_t is the natural log of the Market Value at the end of fiscal year t;

Leverage_t is the book value of debt divided by debt plus the market value of equity both at the end of fiscal year t.

We obtain data from the Compustat Annual Industrial and Research files. The sample size is 42,776 in Panel A and 40,569 in panel B. We winsorize all variables by setting the values in the 1st and 100th percentiles to the minimum and maximum values in the 2nd and 99th percentiles. Observations with deflated EPS values of less than -1 or greater than 1 are winsorized at -1 and +1. In cases where EPS data are absent in any of the years from t+1 through t+5, SD($E_{t+1,t+5}$) is set equal to the mean SD($E_{t+1,t+5}$) of the firms in the same Altman Z-Score decile portfolio (see section 2 for details).

Reported t-tests are adjusted for autocorrelation using the Newey-West correction with 5 lags.

Table 8
Descriptive Statistics
By 2 Digit SIC Code

2 Digit SIC	Industry	N	SD($E_{t+1,t+5}$)			CapEx _t			R&D _t		
			Mean	STD	Median	Mean	STD	Median	Mean	STD	Median
53	General Merchandise Stores	898	0.103	0.028	0.105	0.166	0.445	0.073	0.000	0.001	0.000
54	Food Stores	727	0.100	0.028	0.102	0.240	0.495	0.121	0.000	0.003	0.000
56	Apparel and Accessory Stores	653	0.106	0.029	0.107	0.196	0.523	0.073	0.000	0.001	0.000
58	Eating and Drinking Places	1,070	0.151	0.048	0.143	0.462	0.856	0.219	0.031	0.436	0.000
59	Miscellaneous Retail	968	0.109	0.030	0.113	0.157	0.354	0.070	0.005	0.030	0.000
67	Holding, Othr Invest Offices	1,987	0.113	0.027	0.107	0.055	0.389	0.000	0.022	0.183	0.000
13	Oil and Gas Extraction	1,403	0.133	0.043	0.121	0.563	1.132	0.244	0.028	0.209	0.000
51	Nondurable Goods -Wholesale	914	0.111	0.036	0.110	0.182	0.442	0.064	0.055	0.409	0.000
50	Durable Goods-Wholesale	1,654	0.113	0.036	0.113	0.154	0.558	0.049	0.061	0.462	0.000
99	Other	6,280	0.119	0.039	0.113	0.274	0.761	0.089	0.062	0.428	0.000
27	Printing, Publishing and Allied	790	0.101	0.030	0.099	0.117	0.233	0.039	0.016	0.062	0.000
23	Apparel & Other Finished Pds	573	0.088	0.024	0.085	0.081	0.226	0.038	0.015	0.136	0.000
48	Communications	551	0.137	0.046	0.119	0.285	0.429	0.166	0.106	0.582	0.001
20	Food and Kindred Products	1,619	0.103	0.031	0.100	0.136	0.445	0.075	0.024	0.203	0.002
25	Furniture and Fixtures	607	0.099	0.024	0.100	0.083	0.139	0.047	0.015	0.045	0.004
26	Paper and Allied Products	916	0.111	0.030	0.108	0.158	0.560	0.078	0.032	0.219	0.004
29	Pete Refining & Related Inds	588	0.118	0.028	0.114	0.166	0.240	0.116	0.012	0.034	0.005
33	Primary Metal Industries	1,161	0.110	0.032	0.106	0.135	0.235	0.081	0.048	0.408	0.005
32	Stone, Clay, Glass, Concrete Pd	769	0.110	0.032	0.109	0.177	0.325	0.101	0.032	0.142	0.006
22	Textile Mill Products	740	0.094	0.024	0.092	0.109	0.129	0.073	0.023	0.072	0.007
34	Fabr Metal, Ex Machny, Trans Eq	1,869	0.104	0.033	0.102	0.186	0.645	0.068	0.046	0.268	0.010
30	Rubber & Misc Plastics Prods	1,158	0.109	0.034	0.105	0.149	0.275	0.085	0.043	0.182	0.012
39	Misc Manufacturing Industries	900	0.110	0.034	0.109	0.160	0.469	0.065	0.070	0.356	0.014
37	Transportation Equipment	1,901	0.106	0.030	0.103	0.152	0.423	0.067	0.098	0.532	0.023
87	Engr, Acc, Resh, Mgmt, Rel Sevs	649	0.125	0.045	0.119	0.223	0.577	0.065	0.213	0.666	0.030
28	Chemicals & Pharmaceuticals	4,128	0.118	0.036	0.119	0.159	0.518	0.053	0.187	0.648	0.036
35	Indl, Comml Machy, Computer Eq	6,204	0.114	0.035	0.113	0.185	0.563	0.068	0.161	0.525	0.049
36	Electr, Oth Elec Eq, Ex cmp	5,662	0.114	0.034	0.113	0.179	0.533	0.073	0.158	0.492	0.055
38	Meas Instr; Photo Gds; Watches	4,942	0.120	0.037	0.118	0.186	0.545	0.065	0.212	0.597	0.075
73	Business Services (including software)	2,792	0.130	0.037	0.125	0.263	0.683	0.085	0.291	0.840	0.076
	Total	55,073	0.115	0.095	0.097	0.198	0.577	0.071	0.108	0.477	0.011

This table reports descriptive statistics by 2-digit industry code. The industries are sorted by mean R&D expenditures per share scaled by book value of equity per share.

$SD(E_{t+1,t+5})$ is the standard deviation of earnings per share before extraordinary items and discontinued operations; the standard deviation is calculated using five annual earnings observations for years $t+1$ through $t+5$;

$R\&D_t$ is R&D expense per share;

$CapEx_t$ is capital expenditures per share.