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R&D Uncertainty in Future Benefits

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This paper contributes to the current debate on accounting treatment of R&D expenditures. We considered two different measures of future benefits to a firm, sales revenue and operating cash flows. We provide evidence that R&D expenditures do not generate more uncertain future sales revenue or operating cash flows compared to capital expenditures. In terms of sales revenue, R&D expenditures generate significantly less uncertain future benefits compared to capital expenditures. And in terms of operating cash flows, our results do not provide conclusive evidence that whether R&D expenditures generate more uncertain future benefits than capital expenditures or not.

INTRODUCTION

Our objective in this study is to provide further evidence on the relative degree of uncertainty of future benefits attributable to current research and development (R&D) expenditures and to current capital expenditures. Kothari, Laguerre, and Leone (hereafter KLL) (2002) consider the uncertainty of future earnings in their analysis and find that future earnings from R&D expenditures are more uncertain than future earnings from capital expenditures. In addition to the uncertainty of future earnings, we examine the uncertainty of future sales revenue and operating cash flows. The motivation for looking into sales revenue stems from the fact that all stakeholders in a firm receive, or expect to receive, a stream of income from the firm (Sunder 2008). Total value a firm generates for all of its stakeholders is sales revenue. Sales revenue is an important performance measure because it is useful not only as a summary measure but also in providing new information to the market (Chandra and Ro, 2008). And investors', lenders', and other creditors' expectations about returns depend on their assessment of the amount, timing, and uncertainty of future net cash inflows to the entity (FASB SFAC No. 8). Hence we also included the uncertainty operating cash flows in our analysis.

Our study compares the relative contributions of current R&D and capital expenditures to future earnings variability, sales revenue variability and operating cash flow variability. We use the standard deviation of realized future earnings, sales revenue and operating cash flows as measures for the uncertainty of future benefits. We analyze a sample of over 50,000 firm-year observations from 1987 to 2005 with data on R&D, capital expenditures and estimates of variability in future benefits. We find

mixed evidence on the relationship between R&D expenditures and uncertainty of future benefits. Specifically, similar to KLL (2002), in a regression of future earnings variability on R&D, capital expenditures, and other economic determinants of earnings variability such as leverage and firm size the coefficient on R&D is more than three times as large as that on capital expenditures. However, in a regression of future sales revenue variability on R&D, capital expenditures, and other economic determinants of earnings variability the coefficient on capital expenditures is larger than that on R&D. Further, analysis with future operating cash flows variability does not reveal convincing evidence that the coefficient on R&D is larger than that on capital expenditures.

R&D is an important productive input for a significant number of firms (Aboody and Lev, 2000) and it has increased significantly during the last few decades. We find that corporate spending on R&D increased from \$20.4 billion in 1975 to \$390.4 billion in 2009 peaking at \$467 billion in 2007 for all firms in COMPUSTAT database. In 2009, R&D represents 2.7 percent of total assets and 3.9 percent of total sales revenue for firms which report R&D on their financial statements. The accounting treatment of R&D expenditures requires firms to expense such expenditures in the period incurred (FASB ASC 730-10-25-1). This treatment of R&D has been a topic of question. FASB employs the degree of uncertainty of future benefits as a criterion in determining whether a given cost should be capitalized or expensed. And FASB's perceived degree of uncertainty about future benefits from R&D probably commands the current accounting for R&D expenditures.

Studies that suggest the capitalization of R&D or improved R&D disclosures document evidence that R&D is associated with future performance (Lev and Sougiannis, 1996; Deng and Lev 2006). Additionally, the capitalization (and amortization) of software development costs improves the prediction of future earnings (Aboody and Lev, 1998) and extensive product-development and patent protection disclosure by biotech IPOs reduces risk evidenced by reduced stock volatility and bid-ask spreads (Guo, Lev, and Zhou, 2004). Further, previous studies show that adjusting accounting numbers for capitalization of R&D result in increased association between stock prices and accounting numbers (Lev and Sougiannis, 1996; Lev, Nissim, and Thomas, 2007). Although, the investors understand the capital properties of R&D expenditures they fail to incorporate these benefits fully into stock prices evidenced by positive excess stock market returns experienced by firms with high R&D to market value ratio (Chan, Lakonishok, and Sougiannis (hereafter CLS), 2001). This is probably due to the current accounting treatment of R&D.

On the other hand, consistent with FASB's concern regarding uncertainty, KLL (2002) provides evidence that future benefits from R&D expenditures are more uncertain than future benefits from capital expenditures. This relationship is more pronounced in R&D-intensive industries (Amir, Guan, and Livne, 2007). In addition, firms that have more productive R&D exhibit less volatile future operating performance (Pandit, Wasley, and Zach (hereafter PWZ), 2011) which is still higher than the volatility of future operating performance from capital expenditures. And for bondholders, when credit risk associated with R&D intensive firms is considered, the risks and uncertainties of R&D dominate the future benefits (Shi, 2003). Furthermore, excess returns to R&D intensive firms might be due to the risk associated with R&D expenditures (Chambers, Jennings, Thompson, 2002). Overall, these studies favor the expensing of R&D.

Our results contribute to the current debate on accounting treatment of R&D expenditures. We provide evidence that is contrary to the notion that R&D expenditures generate future benefits that are more uncertain than benefits from expenditures in PP&E. The outline for the remainder of the paper is as follow. Next section provides the background and motivation for our study. After that we present the research design of the paper followed by the results of empirical analysis and our conclusion.

BACKGROUND AND MOTIVATION

Financial Accounting Standards Board (FASB) sets accounting standards in United States that set out Generally Accepted Accounting Principles (GAAP). Primary qualitative characteristics of accounting information FASB considers in setting standards are relevance and representational faithfulness. GAAP

requires R&D expenditures to be expensed in the period incurred (FASB ASC 730-10-25-1) because R&D expenditures do not meet the representational faithfulness and the relevance criteria:

“...there is often a high degree of uncertainty about whether research and development expenditures will provide any future benefits...” (FASB ASC 730-10-5-3)

“At the time most research and development costs are incurred, the future benefits are at best uncertain. In other words, there is no indication that an economic resource has been created... There is normally little, if any, direct relationship between the amount of current research and development expenditures and the amount of resultant future benefits to the entity...” (FASB ASC 730-10-5-2)

Chartered Financial Analyst (CFA) institute, formerly known as the Association for Investment Management and Research (AIMR), is an international, nonprofit organization of more than 70,000 investment practitioners and educators. As an important body of accounting information users they in general concur with FASB's position on R&D expenditures. For example the following statement outlines their position:

“We are not enamored of recording self-developed intangible assets unless their values are readily apparent. We consider the cost of creating them to be so often unrelated to their actual value as to be irrelevant in the investment valuation process. Furthermore, it usually is next to impossible to determine in any sensible or codifiable manner exactly which costs provide future benefit and which do not.”(AIMR, 1993)

Prior research mostly focused on the relevance of R&D expenditures. Sougiannis (1994) examines whether reported accounting earnings reflect benefits from past R&D expenditures. He shows that the total effect of past R&D on earnings ranges from 1.559 in 1978 to 2.829 in 1984 with a mean value of 2.083. He provides evidence that indicate R&D benefits last for seven years. Lev and Sougiannis (1996) provide a procedure to estimate depreciation rates for R&D expenditures in each R&D intensive industry. Using the procedure they capitalize and amortize R&D expenditures. Their estimates indicate that useful life of R&D ranges from five years in Scientific Instruments industry to nine years in Chemicals and Pharmaceuticals industry. Eberhart, Maxwell, and Siddique (2004) analyze the future operating performance of firms with unexpected R&D increases. They show that value-weighted and equal-weighted abnormal profit margin for firms that had unexpected R&D increases within the past five years is significantly positive. Their evidence indicates that R&D increases lead to better than expected future operating performance in terms of profit margin. Hence there is a direct link between a firm's reported total R&D, although not for individual R&D projects, and future operating performance.

While it has been documented that investors on average consider R&D expenditures to be asset (Hirschey, 1982; Lev and Sougiannis, 1996), investors fail to incorporate the effect of R&D expenditures on future operating performance fully into stock prices, that is R&D is underpriced (Lev and Sougiannis, 1996; CLS, 2001). Lev and Sougiannis (1996) present evidence that although capitalized R&D expenditures are associated with contemporaneous stock prices and returns, capitalized R&D expenditures are also associated with subsequent stock returns. Hence they conclude that the contemporaneous stock prices do not fully reflect the R&D benefits. CLS (2001) show that the market on average fully incorporates R&D benefits into stock prices. However their results indicate that firms with high R&D to market value ratio have positive risk-adjusted future excess returns. Eberhart, Maxwell, and Siddique (2004) show that long-term abnormal stock return persists after abnormal increases in R&D expenditures, which is consistent with investors' under-reaction to the new information contained in increased R&D expenditures. Collectively this evidence suggests that the market is inefficient and the inefficiency is due to the investors being misled by conservative accounting for R&D expenditures.

On the other hand KLL (2002) show that future earnings from R&D expenditures are more uncertain than future earnings from capital expenditures. They measure the uncertainty of future earnings as the

future earnings variability. Future earnings variability is measured as standard deviation of five future annual earnings per share. They demonstrate that future earnings generated by R&D are three times more uncertain than future earnings generated by capital expenditures. Further analysis of the relationship between R&D expenditures and uncertainty of future benefits reveals that firms that have more productive R&D exhibit less volatile future operating performance (PWZ, 2011). Shi (2003) analyzes how creditors assess the risks and future benefits of R&D expenditures. The risks of R&D here refer to the credit risk and default risk. He shows that R&D is significantly associated with bond default ratings and bond premium risk. He also shows that R&D alone approximately explains 80 percent of cross-sectional variations in bond ratings and bond risk premium.

Overall, prior research shows that the benefits from past R&D expenditures are reflected in the reported accounting earnings but investors fail to incorporate these benefits fully into stock prices. And these benefits are more uncertain than the benefits from past capital expenditures. In addition, creditors consider R&D expenditures as risk proxies.

The main purpose of this paper is to further explore whether the variability of the realizations of future benefits is greater due to R&D expenditures than to capital expenditures. We use three different proxies for future benefits to a firm: Earnings, Sales revenue, and Operating cash flows. Sunder (2008) discusses the value of a firm under neoclassical economic theory and contract theory. Our first measure of future benefits to a firm is based on prior literature which follows the neoclassical economic theory of firm. In the neoclassical economic theory, a firm is seen as an instrument of the entrepreneur or owner. All agents, other than the owner, are considered passive in the sense that their behavior can be well represented by their respective functions. The owner works with production, supply, and demand functions to maximize the value of the firm he owns. Value to the owner is the value of the firm (Sunder 2008). Financial accounting reports are based on the value to the owner. The objective of financial reporting is to provide financial information about the reporting entity that is useful to external users in making decisions about providing resources to the entity. Hence, the primary focus of financial reporting is information about an enterprise's comprehensive income and its components. Investors, creditors, and others who are concerned with assessing the prospects for enterprise net cash inflows are especially interested in that information (FASB SFAC No. 8). Hence, our first measure of benefits generated by a company for its investors, to replicate the findings of KLL (2002), is earnings.

The rationale for our next measure stems from the contract theory of firm. Under the contract-theoretic view (Barnard, 1936; Simon, 1947; Cyert and March, 1963), a firm is a set of contracts or alliances among agents. Each agent contributes factors of production to the firm, and receives compensation in the form of cash or other resources in exchange. Each agent chooses to participate in the firm if the value of compensation offered by the firm exceeds the opportunity cost of his resource contributions. Hence, all stakeholders in a firm receive, or expect to receive, a stream of income from the firm (Sunder 2008). These stakeholders would include, but is not limited to, investors, creditors, customers, vendors, employees, and government. And the total value a firm generates for all of its stakeholders is its sales revenue. We included sales revenue in our analysis as a measure of total benefits generated by a company for its stakeholders.

Sales revenue is an important performance measure for several reasons. Chandra and Ro (2008) provide evidence that sales revenue is useful not only as a summary measure but also in providing new information to the market. Sales revenue is more useful than earnings in summarizing the performance of technology firms and for profit incidents. Although the new information conveyed by earnings has declined, the new information conveyed by sales revenue has not. Further, earnings surprises that are accompanied by revenue surprises indicate more persistent earnings growth than similar levels of earnings surprises not accompanied by revenue surprises (Jagadeesh and Livnat 2006). Last, but not least, sales revenue models are less biased, better specified, and more powerful than accrual-based models in detecting earnings management (Stubben, 2010).

Prior research provides evidence that demand uncertainty depresses firm investment (Bo, 2002; Fuss and Vermeulen, 2004) and this adverse effect of demand uncertainty on R&D investments is sharper than that of on non-R&D related investments (Goel and Ram, 2001). Hence, we expect firms to invest in R&D

projects that would lead to less volatile sales revenue. Thus R&D would generate less uncertain future sales revenue than capital expenditures.

Our last measure of future benefits also follows the neoclassical economic theory of firm. Decisions by investors about buying, selling, or holding equity and debt instruments depend on the returns that they expect such as dividends, principal and interest payments, or market price increases. Similarly, decisions by creditors about providing or settling loans and other forms of credit depend on the principal and interest payments that they expect. Hence investors' and creditors' expectations about returns depend on their assessment of the amount, timing, and uncertainty of future net cash inflows to the entity (FASB SFAC No. 8). Although, information about earnings based on accrual accounting usually provides a better inference of a firm's ability to generate cash flows, the end goal is assessing the prospects for future net cash inflows to a firm. Hence, uncertainty of future net cash inflows would be more relevant to investors and creditors than uncertainty of future earnings. Consequently, our last proxy for benefits generated by a company for its investors and creditors is operating cash flows.

Minton and Schrand (1999) provides evidence that higher cash flow volatility leads to lower average levels of investment in capital expenditures, R&D, and advertising. And this relationship is strongest for R&D after controlling for cash flow levels. Thus firms which rely on R&D for innovation would invest in R&D projects that would lead to less volatile cash flows. Hence we expect R&D to generate less uncertain future cash flows than capital expenditures.

RESEARCH DESIGN

Empirical Model

To explore the notion that the variability of future benefits is more sensitive to R&D expenditures than capital expenditures, we estimate the following model (firm subscript *i* is suppressed) from KLL (2002):

FIGURE 1 FUTURE UNCERTAINTY EQUATION

$$STDEV(FV_{t+1,t+5}) = \alpha + \beta_{1t} CapEx_t + \beta_{2t} RND_t + \beta_{3t} ADV_t + \beta_{4t} MV_t + \beta_{5t} Leverage_t + e_{t+1,t+5}$$

STDEV(FV_{t+1,t+5}) is the standard deviation of future benefits; Proxies for FV are sales revenue (*S_t*), earnings before extraordinary items and discontinued operations (*E_t*), or operating cash flows (*CF_t*); the standard deviation is calculated using five annual observations for years *t+1* through *t+5*; each observation is deflated either by the book value of equity, BKV, or by stock price, PRC, at the beginning of the period *t*; CapEx_{*t*} is the capital expenditure per share, deflated by BKV or PRC; RND_{*t*} is research and development per share, deflated by BKV or PRC; ADV_{*t*} is advertising expense per share, deflated by BKV or PRC; 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*.

Our focus is on the coefficients of R&D and capital expenditures. However, we include advertising, leverage, and market value as control variables which are motivated for inclusion by KLL (2002). Based on the results of KLL (2002), we expect advertising and leverage to be positively associated with variability of future benefits, while market value of firm is expected to be negatively associated with variability of future benefits.

Sample Selection

We obtain financial data from the Compustat Annual Industrial and Annual Research files for the period 1987-2005. For each year *t* from 1987 to 2005, we retain all observations with non-missing data for the following: CapEx_{*t*} is capital expenditures, Compustat data CAPX; RND_{*t*} is research and development expense, data XRD, a zero reported amount is not treated as a missing value; ADV_{*t*} is

advertising expense, data XAD, a missing value is set to zero; 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 [$\log(\text{PRCC_F} * \text{CSHPRI})$]; Leverage_t is the sum of long-term debt, data DLTT, and debt in current liabilities, data DLC, divided by the sum of long-term debt and the market value of equity; E_t is the primary earnings per share before extraordinary items and discontinued operations, data EPSPX; S_t is sales revenue, data SALE, divided by the number of common shares; CF_t is cash flows from operations, data OANCF, divided by the number of common shares; PRC is share price, data PRCC_F; and BKV is the stockholders' equity, data SEQ, divided by the number of common shares outstanding. We exclude negative BKV firms when BKV is used as the deflator.

PRC and BKV are measured at the end of fiscal year t-1 because they are used as deflators. Per share values of PRC, BKV, and future benefits, FV_{t+1} to FV_{t+5} , are adjusted for stock splits and stock dividends using the cumulative adjustment factor, Compustat data AJEX, so that they are comparable to the per share values of the remaining variables for year t. Our sample period is from 1987 to 2005 since the first date when operating cash flows data is available is 1987. And because variability of future benefits is calculated using data for five years following year t, the last year of the sample period is 2005.¹

Research intensive firms are likely to go through mergers and acquisitions, and not survive the five year period required to calculate variability of future benefits (PWZ, 2011). This would lead to survivorship-bias. Even though future benefits variability is calculated using five years of future data, to avoid survivor bias, following KLL (2002)'s approach, we do not require future benefits data availability for years t+1 to t+5 for a firm-year to be included in the data. In cases where future benefits data are missing in any of the periods from t+1 through t+5, the standard deviation of future benefits, $\text{STDEV}(FV_{t+1,t+5})$ is set equal to the mean of $\text{STDEV}(FV_{t+1,t+5})$ for the firms in the same Altman Z-Score decile portfolio.²

The ending sample consists of a total of 51,866 firm-year observations when book-value of equity is used as the deflator and 51,837 observations when price is used as the deflator. Deflators are used to mitigate heteroscedasticity in the regressions.

Descriptive Statistics

Panel A of Table 1 presents the descriptive statistics for the variables deflated by PRC. We winsorize Sales, RND, CapEX, ADV, MV, and leverage at the top and bottom one percent of their distribution each year. We winsorize deflated earnings variable at -1 and +1. And, Panel B of Table 1 presents the descriptive statistics for the variables deflated by BKV. Average spending for capital expenditures are 7.38% of their share price and 15.34% of their book value. Firms spend 6.73% of their share price and 18.49% of their book value on R&D expenditures. Our sample firms are, on average, loss firms. Average earnings per share are -0.0574, deflated by PRC, and -0.0668, deflated by BKV. The median earnings are positive. Average and median standard deviation of future earnings are similar to those of future cash flows. The average (median) standard deviation of future earnings are 0.1359 (0.0936), deflated by PRC, and 0.1734 (0.1440), deflated by BKV. And the average (median) standard deviation of future cash flows are 0.1310 (0.0955), deflated by PRC, and 0.1873 (0.1554), deflated by BKV. The average standard deviation of future sales revenue is much higher than those of earnings and cash flows.

TABLE 1
DESCRIPTIVE STATISTICS

Panel (a): Scaled by PRC

	N	Mean	Standard Deviation	Q1	Median	Q3
RND _t	51,837	0.0673	0.1094	0.0049	0.0307	0.0824
CapEx _t	51,837	0.0738	0.1172	0.0126	0.0363	0.0856
ADV _t	51,837	0.0229	0.0914	0.0000	0.0001	0.0067
MV _t	51,837	-2.2565	2.4038	-3.9861	-2.4572	-0.6767
Leverage _t	51,837	0.2707	0.4437	0.0127	0.1280	0.3621
Earnings _t	51,837	-0.0574	0.2567	-0.1049	0.0199	0.0674
Sales _t	51,837	2.1427	4.2643	0.3425	0.9702	2.2359
Cash Flows _t	51,837	0.0466	0.2560	-0.0442	0.0478	0.1274
SD(E _{t+1,t+5})	51,837	0.1359	0.1252	0.0419	0.0936	0.2043
SD(S _{t+1,t+5})	51,837	1.0645	1.5649	0.2144	0.5690	1.3022
SD(CF _{t+1,t+5})	51,837	0.1310	0.1174	0.0517	0.0955	0.1815

Panel (b): Scaled by BKV

	N	Mean	Standard Deviation	Q1	Median	Q3
RND _t	51,866	0.1849	0.3400	0.0119	0.0791	0.2077
CapEx _t	51,866	0.1534	0.2370	0.0349	0.0856	0.1760
ADV _t	51,866	0.0417	0.1511	0.0000	0.0005	0.0178
MV _t	51,866	-2.1750	2.3560	-3.8541	-2.3636	-0.6504
Leverage _t	51,866	0.2379	0.3570	0.0090	0.1121	0.3297
Earnings _t	51,866	-0.0668	0.4026	-0.2236	0.0456	0.1598
Sales _t	51,866	3.3483	4.6971	1.0626	2.1268	3.7668
Cash Flows _t	51,866	0.0083	0.6619	-0.1052	0.1087	0.2647
SD(E _{t+1,t+5})	51,866	0.1734	0.1227	0.0823	0.1440	0.2473
SD(S _{t+1,t+5})	51,866	0.9322	0.9791	0.3219	0.6474	1.2555
SD(CF _{t+1,t+5})	51,866	0.1873	0.1299	0.0979	0.1554	0.2450

Correlations

Table 2 provides the univariate correlations among the regression variables. While correlations for variables scaled by PRC are reported above the diagonal, correlations for variables scaled by BKV are reported below the diagonal. Both R&D and capital expenditures are positively correlated with different measures of variability of future benefits. The correlations between capital expenditures and different measures of variability of future benefits are all larger than those of between R&D expenditures and variability of future benefits when the deflator is PRC. But when BKV is the deflator, only correlations between capital expenditures and variability between future sales revenue is larger than R&D expenditures and variability of future sales revenue. Nevertheless, we cannot interpret these correlations as marginal impacts on variability of future benefits.

TABLE 2
CORRELATIONS

	RND _t	CapEx _t	ADV _t	MV _t	Leverage _t	SD(E _{t+1,t+5})	SD(S _{t+1,t+5})	SD(CF _{t+1,t+5})
RND _t	1.000	0.082 <.0001	0.008 0.0557	-0.213 <.0001	0.067 <.0001	0.166 <.0001	0.013 0.0036	0.100 <.0001
CapEx _t	0.239 <.0001	1.000	0.258 <.0001	-0.066 <.0001	0.345 <.0001	0.345 <.0001	0.275 <.0001	0.200 <.0001
ADV _t	0.060 0.0557	0.252 <.0001	1.000	-0.103 <.0001	0.195 <.0001	0.083 <.0001	0.151 <.0001	0.117 <.0001
MV _t	-0.072 <.0001	0.086 <.0001	-0.004 0.3370	1.000	-0.275 <.0001	-0.424 <.0001	-0.235 <.0001	-0.372 <.0001
Leverage _t	-0.107 <.0001	0.105 <.0001	0.074 <.0001	-0.250 <.0001	1.000	0.312 <.0001	0.373 <.0001	0.341 <.0001
SD(E _{t+1,t+5})	0.234 <.0001	0.033 <.0001	0.039 <.0001	-0.330 <.0001	0.142 <.0001	1.000	0.543 <.0001	0.704 <.0001
SD(S _{t+1,t+5})	0.063 <.0001	0.116 <.0001	0.104 <.0001	-0.253 <.0001	0.289 <.0001	0.556 <.0001	1.000	0.725 <.0001
SD(CF _{t+1,t+5})	0.211 <.0001	0.043 <.0001	0.052 <.0001	-0.358 <.0001	0.181 <.0001	0.698 <.0001	0.587 <.0001	1.000

Pearson correlations are reported. P-values are reported below correlations.

Correlations when variables are scaled by PRC are reported above the diagonal.

Correlations when variables are scaled by BKV are reported below the diagonal.

EMPIRICAL RESULTS

We estimate the future uncertainty equation using pooled ordinary least squares regression³. We adjust the standard errors for heteroskedasticity, serial-, and cross-sectional correlation using a two-way cluster at the firm and year level which was suggested by Petersen (2009) as the preferred method for estimating standard errors using panel data.

Earnings

We present our results with the standard deviation of future earnings as the independent variable in Table 3 below. This table contains results using both PRC and BKV as the deflators. Results are in line with the results of Kothari et al. (2002). The coefficient estimates on R&D are 0.0866 (t-statistics of 16.31) when PRC is the deflator and 0.0816 (t-statistics of 43.64) when BKV is the deflator. The corresponding average coefficient estimates on capital expenditures are 0.0264 (t-statistics of 4.48) and -0.0057 (t-statistics of -2.30). Interestingly, when BKV is the deflator, capital expenditures seem to reduce the uncertainty in future earnings. An F-test for the equality of coefficients indicates that the coefficient on R&D is significantly larger than the coefficient on capital expenditures. We report F-values of 144.29 when PRC is the deflator and 959.21 when BKV is the deflator. Overall, results show that, consistent with Kothari et al. (2002), R&D expenditures' contribution to uncertainty in future earnings is significantly higher than capital expenditures' contribution.

The coefficients on control variables in the empirical model, advertising, market value and leverage, have their expected signs. That is the coefficients on advertising and leverage are positive while the coefficient on market value is negative. However, the coefficient on advertising is insignificant when the deflator is PRC.

TABLE 3
R&D AND FUTURE EARNINGS VARIABILITY

Variable	Scaled by PRC			Scaled by BKV		
	Coefficient Estimate	t-stat	p-value	Coefficient Estimate	t-stat	p-value
Intercept	0.0714	104.50	<.0001	0.1181	157.29	<.0001
RND _t	0.0866	16.31	<.0001	0.0816	43.64	<.0001
CapEx _t	0.0264	4.48	<.0001	-0.0057	-2.30	0.0217
ADV _t	0.0015	0.23	0.8142	0.0165	4.15	<.0001
MV _t	-0.0183	-90.98	<.0001	-0.0151	-	<.0001
Leverage _t	0.0568	31.46	<.0001	0.0320	71.45	<.0001
R-Squared (%)	22.75			16.22		
F-Value	144.29		<.0001	959.21		<.0001

SD($E_{t+1,t+5}$) is the dependent variable. t-statistics are calculated after adjusting the standard errors for heteroskedasticity, serial-, and cross-sectional correlation using a two-way cluster at the firm and year level. F-Value is to test the equality of coefficients on RND and CapEx.

Sales Revenue

We present our results with the standard deviation of future sales revenue as the independent variable in Table 4. Similar to Table 3, we present the estimation results using beginning both PRC and BKV as the deflators. The coefficient estimates, when PRC is the deflator, on R&D and capital expenditures are -0.7519 (t-statistics of -10.79) and 2.2195 (t-statistics of 21.61), respectively. When BKV is the deflator, the coefficient estimates on R&D and capital expenditures are 0.1457 (t-statistics of 9.68) and 0.3481 (t-statistics of 14.81), respectively. We report F-values of 274.49 when PRC is the deflator and 184.04 when BKV is the deflator to test the equality of coefficients. This indicates that the coefficient on R&D is significantly smaller than the coefficient on capital expenditures. In contrast to the results for earnings, our results for sales revenue provide evidence contrary to the notion that R&D expenditures generate more uncertain future benefits than investments in capital assets.

Prior research provide evidence that demand uncertainty depresses firm investment (Bo, 2002; Fuss and Vermeulen, 2004) and this adverse effect of demand uncertainty on R&D investments is more salient than that of on non-R&D related investments (Goel and Ram, 2001). The evidence that R&D budgets are often determined as a percentage of firm sales revenue (Scherer, 2001; Tubbs, 2007) indicates that firms determine the level of R&D spending based on availability of resources. Therefore, our result that R&D generates less uncertain future sales revenue is consistent with our firms investing in R&D projects that would lead to less volatile sales revenue.

The coefficients on control variables in the empirical model, advertising, market value and leverage, have their expected signs. That is the coefficient estimates on advertising and leverage are positive while the coefficient on market value is negative. And all of the coefficient estimates are statistically significant.

TABLE 4
R&D AND FUTURE SALES REVENUE VARIABILITY

Variable	Scaled by PRC			Scaled by BKV		
	Coefficient Estimate	t-stat	p-value	Coefficient Estimate	t-stat	p-value
Intercept	0.4485	45.45	<.0001	0.5048	79.23	<.0001
RND _t	-0.7519	-10.79	<.0001	0.1457	9.68	<.0001
CapEx _t	2.2195	21.61	<.0001	0.3481	14.81	<.0001
ADV _t	0.6880	5.24	<.0001	0.4013	10.00	<.0001
MV _t	-0.1022	-38.71	<.0001	-0.0824	-45.11	<.0001
Leverage _t	0.9463	28.28	<.0001	0.6349	38.32	<.0001
R-Squared (%)	18.82			13.64		
F-Value	274.49		<.0001	184.04		<.0001

SD($S_{t+1,t+5}$) is the dependent variable. t-statistics are calculated after adjusting the standard errors for heteroskedasticity, serial-, and cross-sectional correlation using a two-way cluster at the firm and year level. F-Value is to test the equality of coefficients on RND and CapEx.

Operating Cash Flows

We present our results with the standard deviation of future operating cash flows as the independent variable in Table 5. Similar to Tables 3 and 4, this table also contains results using both PRC and BKV as the deflators. The coefficient estimates on R&D are 0.0136 (t-statistics of 2.78 when PRC is the deflator and 0.0765 (t-statistics of 38.26) when BKV is the deflator. The corresponding coefficient estimates on capital expenditures are 0.0991 (t-statistics of 16.82) and 0.0013 (t-statistics of 0.48). The results of our analysis with cash flows are not robust to the choice of the deflator. The implication, when PRC price is the deflator, is that capital expenditures generate significantly more uncertain cash flows than R&D expenditures. The significance is indicated by an F-value of 147.65. The results, when BKV is the deflator, indicates that R&D expenditures generate significantly more uncertain cash flows than capital expenditures evidenced by an F-value of 753.28. Further, the coefficient estimate on capital expenditures is statistically insignificant. Overall, we cannot conclude that R&D expenditures' contribution to uncertainty in future operating cash flows is significantly higher than capital expenditures' contribution or vice versa.

Results, when PRC price is the deflator, are consistent with the evidence that higher cash flow volatility leads to lower average levels of investment in capital expenditures, R&D, and advertising (Minton and Schrand, 1999). And this relationship is strongest for R&D after controlling for cash flow levels. This would imply that to the degree that expected cash flow volatility is accurately predicts realized volatility; firms would invest in R&D projects that would lead to less volatile cash flows. And the results, when BKV price is the deflator, might be a manifestation of book value of equity being understated due to the accounting convention of expensing R&D expenditures.

In contrast to our results PWZ (2011) finds that R&D expenditures' contribution to uncertainty in future operating cash flows is higher than capital expenditures' contribution. We don't believe their results are comparable to ours because there are several differences between their study and ours. First, they adjust reported cash flow measure by adding back R&D and advertising. Second, they do no test the significance of the difference of coefficient on R&D and capital expenditures and they do not conclude that they are significantly different. And last, a minor difference, we use per share variables while they use levels of variables.

Similar to Table 4, the coefficients on control variables in the empirical model, advertising, market value and leverage, have their expected signs. That is the coefficient estimates on advertising and

leverage are positive while the coefficient on market value is negative. And all of the coefficient estimates are statistically significant.

TABLE 5
R&D AND FUTURE OPERATING CASH FLOW VARIABILITY

Variable	Scaled by PRC			Scaled by BKV		
	Coefficient Estimate	t-stat	p-value	Coefficient Estimate	t-stat	p-value
Intercept	0.0734	109.66	<.0001	0.1238	158.99	<.0001
RND _t	0.0136	2.78	0.0054	0.0765	38.26	<.0001
CapEx _t	0.0991	16.82	<.0001	0.0013	0.48	0.6300
ADV _t	0.0221	3.12	0.0018	0.0251	5.93	<.0001
MV _t	-0.0146	-75.23	<.0001	-0.0172	-77.15	<.0001
Leverage _t	0.0582	29.72	<.0001	0.0444	28.44	<.0001
R-Squared (%)	20.98			17.78		
F-Value	147.65		<.0001	753.28		<.0001

SD(CF_{t+1,t+5}) is the dependent variable. t-statistics are calculated after adjusting the standard errors for heteroskedasticity, serial-, and cross-sectional correlation using a two-way cluster at the firm and year level. F-Value is to test the equality of coefficients on RND and CapEx.

CONCLUSION

The FASB's ASC 730-10 notes that the trade-off between relevance and uncertainty of future benefits is a major consideration in expensing of R&D expenditures. The trade-off suggests balancing the demand for value-relevant information by equity investors, with the demand for information that has representational faithfulness about future benefits, by debt holders and other stakeholders. KLL (2002) provides evidence in support for the uncertainty of future benefits from R&D expenditures. In this study, we further explore the uncertainty of future benefits of R&D expenditures relative to capital expenditures. KLL (2002) used future earnings variability as a proxy for the uncertainty of future benefits. In addition to future earnings variability, we consider future sales revenue variability and future operating cash flow variability as a proxy for the uncertainty of future benefits.

Similar to KLL (2002), our results support the notion that R&D investments generate more uncertain future earnings compared to capital expenditures. However, our analysis for uncertainty in future sales revenue and future operating cash flows reveal a different picture. In terms of sales revenue, R&D investments generate less uncertain future benefits compared to capital expenditures. And in terms of operating cash flows, we cannot conclude that R&D expenditures' contribution to uncertainty in future operating cash flows is significantly higher than capital expenditures' contribution or vice versa. To the degree that expected future uncertainty accurately predicts realized volatility, our results are manifestation of the fact that managers reduce their outlays in R&D more than capital investments when they expect uncertain demand.

We believe that our study contributes to the current debate over accounting for R&D expenditures. A number of studies provide evidence that the capitalization of R&D would help 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-faithful representation tradeoff. Our study provides evidence that is contrary to the notion that R&D expenditures generate future benefits that are more uncertain than benefits from expenditures in PP&E. Therefore, we provide standard setters with a relative measure of the faithful representation of future benefits component of the relevance-faithful representation trade-off.

ENDNOTES

¹ We repeat our analysis with sales and earnings over the period included in Kothari et al. (2002). The results, not tabulated in the paper, are comparatively similar.

² The decile portfolio average earnings variability is calculated using data for surviving firms only.

³ Similar to KLL (2002), we also estimate future uncertainty equation for each year from 1987 to 2005 and calculate the summary statistics from these thirty-four regressions. The results, not tabulated in the paper, are comparatively similar.

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