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What Role Do Tech Companies' R&D Expenditures Play in Analysts Sales and Earnings Forecasts?

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What Role Do Tech Companies' R&D Expenditures Play in Analysts' Sales and Earnings Forecasts?

By

Vijaykumar Gandapodi

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

Of

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ACCEPTANCE

This dissertation was prepared under the direction of Sergio Quinones-Romandia Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Executive Doctorate in Business in the J. Mack Robinson College of Business of Georgia State University.

Richard Phillips, Dean

DISSERTATION COMMITTEE

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ABSTRACT

What Role Do Tech Companies' R&D Expenditures Play in Analysts' Sales and Earnings Forecasts?
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Many top market capitalization companies are information technology (IT) firms, including Apple, Google, Microsoft, and Facebook, each of which is valued at more than $300 billion. Facebook is less than 10 years old and is one of the top 10 companies in the world in terms of market capitalization. However, technologies change rapidly; website revenue—which once grew at a brisk rate—has slowed down, while mobile technology growth is increasing and technology trends are shifting toward cloud hosting and big data analytics. IT companies that have increased their R&D spending remain leaders throughout periods of technology change. Companies such as Facebook and Google have doubled and tripled their profits, respectively over` the past decade. In this dynamic environment, analysts play a critical role in evaluating IT company financial statements and estimating company sales and earnings per share (EPS). This study examines how changes in R&D spending are related to analysts' sales and earnings estimate revisions. An analysis of data over a 20-year period shows that analysts typically revise their sales estimates based on changes in a company's R&D expenditures. The correlation between analyst earnings estimates and R&D expenditures, however, varies based on company size and industry within the IT sector. Analysts play a particularly important role in small companies, where the correlation between R&D and sales changes is not as high as in

large companies. Analysts are thus critical to the functioning of capital markets in the IT sector.

I CHAPTER 1: INTRODUCTION

In this research study, I explore whether analysts' revisions in sales and earnings per share (EPS) estimates are related to R&D expenditure changes by technology companies. This issue is of interest to both stock market participants and managers of these firms. With the rising pressure to create and sustain competitive advantages through technological innovation, IT companies increasingly depend on the efficient management of research and development (R&D) activities (Bone & Saxon, 2000). R&D investments are a critical element of growth in firms (Chan, Martin & Kensinger, 1990). Market participants use analysts' forecasts because analysts process and transform the information contained in financial statements—along with additional information about the industry, firm strategy, and economy—into future earnings predictions (Wieland, 2011). Analysts' forecast revisions promote market price discovery (Gleason & Lee, 2003) and market participants react to forecast revisions.

The problem statement for this study is: "What role do technology companies' R&D expenditures play in analysts' sales and earnings forecasts?" This study zeros in on IT companies, extracting records filtered for that sector (group 45) from the Wharton Research Data Services (WRDS) Compustat database, with a focus on IT companies that have R&D expenditures on their balance sheets. I extracted analysts' forecasts for IT company sales and EPS for the current and the following year from the Institutional Brokers' Estimate System (I/B/E/S) database.

This research focuses on companies trading in US exchanges. I categorize companies by size into small, midsized, and large based on market capitalization. I also examine various industries within the IT sector; as one study found, R&D intensity that is higher

than the particular industry's average leads to larger stock-price increases for firms in high-tech industries (Chan, Martin & Kensinger, 1990).

I observe that analysts do change their sales forecasts in response to changes in R&D expenditures by technology firms. The relation is robust across three different sectors of the IT industry. Analysts also change their EPS estimates in response to changes in R&D, although this relation is not as strong when I consider changes in sales. Interestingly, I find that in the smallest capitalization firms, analysts change EPS estimates in response to changes in R&D, even when sales changes are considered. I consider this as evidence of the importance of analysts to capital allocation in the technology industry.

The findings I captured during my analysis add to the academic research related to R&D expenditure and analyst estimates. Research spending is heavily concentrated in technology and science-oriented industries. The computer programming, software, and services industry represents about 17 percent of the sales and two times the earnings compared to other companies in these sectors. Other research (Chan, Lakonishok & Sougiannis, 2001) focuses on R&D, but does not concentrate on the analyst aspect. This study will benefit practitioners, allowing them to make smarter investments based on R&D expenditure. Further, analysts' recommendations on EPS and sales have a correlation with stock prices. Huo and Hung (2014) show that stock price drift emerges after analysts' revise their earnings forecasts.

The study will also benefit managers of technology companies by clarifying how analysts make revisions. For small firms, analysts play a particularly important role, as these firms tend to have less market coverage.

Analyst forecasts are superior to time-series forecasts because analysts possess both an information advantage and a timing advantage (Brown, 1987). Keung's study (2010) finds that earnings forecast revisions supplemented with sales forecast revisions have a greater impact on security prices than stand-alone earning forecast revisions. He further found that financial analysts are more likely to supplement their earnings forecasts with sales forecasts when they have better information. As Keung's study discusses in detail, supplementary sales forecasts appear to lend credibility to earnings forecasts because financial analysts provide better sales forecasts when they are more informed. These findings help us understand the characteristics of analysts' sales and EPS forecasts.

II CHAPTER 2: LITERATURE SYNTHESIS

R&D in technology companies is important for several reasons. For example, it influences executives' incentives, compensation, and firm performance. Currim, Lim, and Kim (2012) found the increase in equity-to-bonus compensation ratio for top executives is positively associated with an increase in R&D spending. Further, in their work on analyst forecast revisions and market price discovery, Gleason and Lee found a post-revision price drift associated with these forecast revisions (Gleason & Lee, 2003). Also, changes in R&D expenditure in either direction indicate transitions between exploitative and exploratory R&D and are associated with increased firm performance (Mudambi & Swift, 2014). Such examples illustrate the importance of R&D expenditure and how it impacts top executives' compensation and the stock price performance of firms.

This association is more intense in high-growth firms and is especially significant in the high-tech sector (García-Manjón & Romero-Merino 2012). This study further found that policymakers and business leaders in the high-tech sector maintain R&D expenditures even when facing a recession. Graham and Frankenberger (2008) report that increases in R&D spending in recessions increase firm profit and intangible value. Even during the recession, companies reduce R&D spending to meet their quarterly results, which in turn impacts the growth of the firm. As this literature synthesis shows, R&D spending is a key metric for increasing or decreasing firm's earnings.

R&D is also important to market participants. The study by Kumar, Charurvedula, Rastogi, and Bang (2009) found that buy recommendations issued by analysts help investors generate abnormal returns on the day of the recommendation. On the other hand, sell recommendations do not show significant negative abnormal returns.

An analyst forecast revision and market price discovery study by Gleason and Lee (2003) found that post-revision price drift is associated with analyst forecast revisions. That study documents the following four significant factors:

1. The market does not sufficiently distinguish between revisions that provide new information and revisions that merely move toward the consensus.
2. The price adjustment process is faster and more complete for celebrity analysts than for more obscure yet highly accurate analysts.
3. The price adjustment process is faster and more complete for firms with greater analyst coverage.
4. A substantial portion of the delayed price adjustment occurs around subsequent earnings-announcement and forecast-revision dates.

The above studies confirm that investors use analyst information for investing in the stock market. Hillary and Hsu (2013) empirically showed that analysts with a lower standard deviation of forecast errors have a greater ability to move prices. These results have three implications:

1. Consistent analysts are less likely to be demoted and more likely to be nominated as all-star analysts.
2. Analysts strategically deliver downward-biased forecasts to increase their consistency (sometimes at the expense of stated accuracy).
3. The benefits of consistency and of "lowballing" (accuracy) are to increase (or decrease) the institutional investor's presence.

These findings help us understand that analyst reports are used not only by individual investors, but also by institutional investors.

Fama and French (1992) also found positive abnormal returns associated with high Earnings to Price (E/P**)** stocks, but they found an even stronger relationship between book value to price (B/P) ratios and abnormal returns. Bauman and Dowen (1988) discovered mixed results between high growth stocks and stock returns; during their study, they found long-term, low growth stocks with low P/E had higher return than higher growth stocks with higher P/E. These studies help us to understand the importance of the EPS; the Fama and French (1992) study confirms the significance of a company's earnings for the share price being traded. This literature synthesis illuminates how the investment community uses analyst forecast reports.

Analysts offer significantly greater coverage for firms with larger R&D and advertisement expense relative to their industry, as well as for firms in industries with large R&D expenses (Barth, Kasniz & McNicholas, 1999). As Figure 1 shows, the US National Science Foundation offers a reliable source for R&D trends for US companies and government, with a steady transfer of R&D spending from government to the business sector.

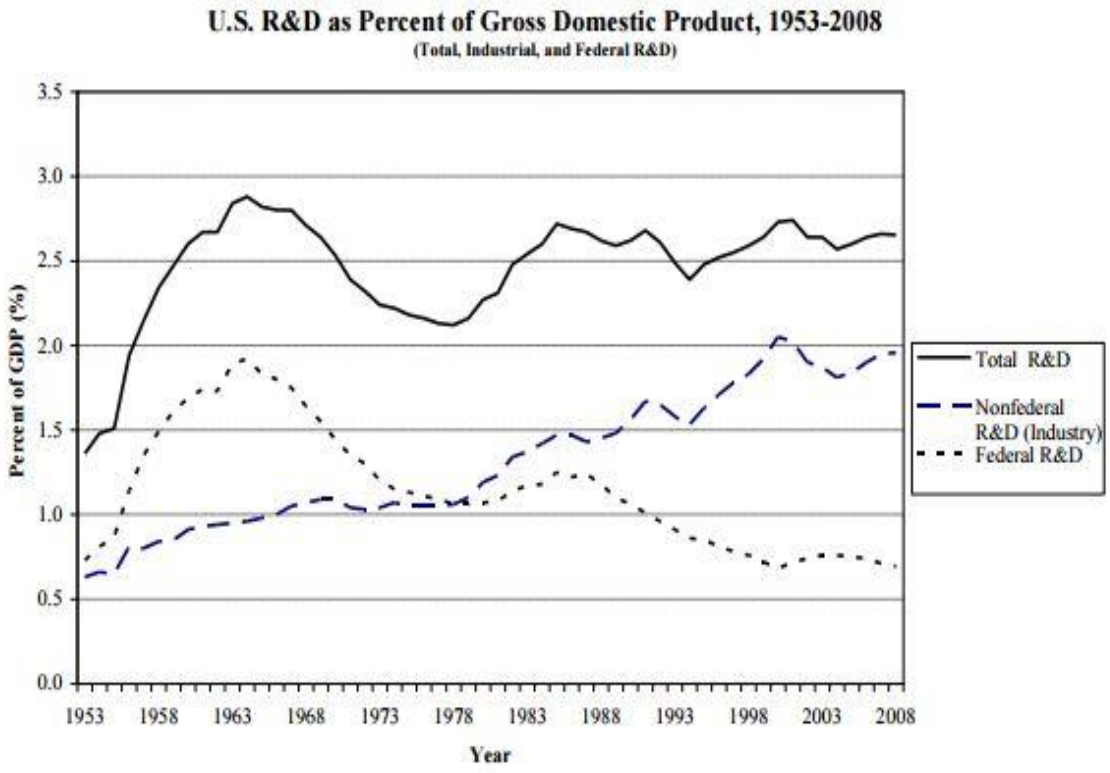

Figure 1 U.S. R&D as Percent of Gross Domestic Product, 1953-2008

Source – National Science Foundation, (Hirschey et al. 2012)

Similar to current cash flow, growth, risk, and market share, advertising and R&D expenditures are key determinants of a firm's market value (Chauvin & Hirschey 1993). Chauvin and Hirschey's also found that the market value effects of advertising and R&D are broadly operative throughout both manufacturing and nonmanufacturing sectors. They suggest that advertising and R&D are an attractive alternative means of investment in valuable intangible capital that have differing degrees of relevance in different economic sectors.

Sougiannis (1994) found that, on average, a one-dollar increase in R&D leads to a two-dollar increase in profit over a seven-year period, with a five-dollar increase in

market value. Companies with high R&D-to-equity-market value (which tend to have poor past returns) earn large excess returns (Chan, Lakonishok & Sougiannis, 2001). Analyst accrual and forecast revision strategies generate returns of 15.5 percent and 5.5 percent, respectively, when implemented independently (Bath & Hutton, 2003). Bath and Hutton add that a combined strategy that uses forecast revisions to refine the accrual strategy generates a return of 28.55 percent. They further discuss many studies pertaining to analyst earnings forecast; some of these studies argue that analysts don't account for key accounting data (Stober, 1992; Abarbanell & Bushee, 1997). However, other studies point out that analyst forecasts are more accurate than time-series models in predicting future earnings (Brown, Griffin, Hagerman & Zmijewski, 1987). Such research suggests that analyst forecasts have the potential to give investors value-relevant information about earnings (Bath & Hutton, 2003).

Bath and Hutton note that a second stream of analyst forecast research focuses on whether investors actually heed the information in analyst forecast revisions. Numerous studies (e.g., Givoly & Lakonishok, 1980; DeBondt, 1991; Mendenhall, 1991; Stickel, 1991; Gleason & Lee, 2000; and Elgers, Lo, & Pfeiffer, 2001) have found that analyst forecast revisions predict future returns, indicating that investors do not fully utilize the information reflected in the forecasts on a timely basis.

In their study, Hirschey et al. (2012) found that R&D spending continues to grow faster than advertising and capital expenditures. As Figure 2 shows, they found that IT companies and small market capitalization companies that spend on R&D increased their spending by 57 percent between 1976 and 2010, while non-IT sector companies and large

companies (which constitute most of the NYSE) reduced such spending by 12 percent. The data in the Figure 2 does not include financial or utilities sector companies.

				All Industrial firms			NYSE firms			AMEX, NASDAQ firms		
Year	CRSP Industrial firms	NYSE industrials	AMEX, NASDAQ industrials	R&D	Advertising	Capex	R&D	Advertising	Capex	R&D	Advertising	Capex
1976	2663	906	1757	1,203	1284	2632	495	444	899	708	840	1,733
1977	2649	900	1749	1,160	1270	2622	480	430	893	680	840	1,729
1978	2589	898	1691	1,122	1225	2552	469	439	888	653	786	1,664
1979	2574	881	1693	1,114	1220	2542	458	431	875	656	789	1,667
1980	2640	874	1766	1,135	1191	2607	451	404	865	684	787	1,742
1981	2864	858	2006	1,241	1210	2799	439	389	849	802	821	1,950
1982	2903	836	2067	1,290	1225	2846	429	374	830	861	851	2,016
1983	3289	841	2448	1,495	1453	3195	429	383	830	1,066	1,070	2,365
1984	3442	826	2616	1,570	1551	3332	413	385	813	1,157	1,166	2,519
1985	3506	804	2702	1,601	1556	3378	398	355	785	1,203	1,201	2,593
1986	3710	782	2928	1,673	1666	3576	378	340	759	1,295	1,326	2,817
1987	3864	799	3065	1,704	1691	3724	383	341	780	1,321	1,350	2,944
1988	3695	793	2902	1,659	1609	3576	379	334	779	1,280	1,275	2,797
1989	3567	794	2773	1616	1515	3436	377	329	775	1,239	1,186	2,661
1990	3525	830	2695	1590	1463	3407	389	326	814	1,201	1,137	2,593
1991	3591	878	2713	1663	1442	3452	412	341	860	1,251	1,101	2,592
1992	3770	951	2819	1779	1423	3667	439	361	933	1,340	1,062	2,734
1993	4187	1013	3174	1939	1500	4084	455	385	991	1,484	1,115	3,093
1994	4406	1066	3340	1999	734	4314	473	204	1,047	1,526	530	3,267
1995	4602	1098	3504	2154	741	4495	488	206	1,076	1,666	535	3,419
1996	4986	1186	3800	2385	945	4866	498	254	1,157	1,887	691	3,709
1997	5000	1235	3765	2416	1034	4880	513	273	1,200	1,903	761	3,680
1998	4723	1241	3482	2292	1032	4607	520	285	1,211	1,772	747	3,396
1999	4551	1184	3367	2275	1198	4447	508	309	1,156	1,767	889	3,291
2000	4391	1091	3300	2308	1301	4294	463	309	1,063	1,845	992	3,231
2001	3942	1071	2871	2138	1281	3844	460	340	1,044	1,678	941	2,800
2002	3662	1071	2591	1972	1294	3608	462	369	1,063	1,510	925	2,545
2003	3444	1056	2388	1840	1307	3403	465	399	1,050	1,375	908	2,353
2004	3441	1056	2385	1872	1411	3410	471	432	1,053	1,401	979	2,357
2005	3396	1043	2353	1836	1433	3357	463	440	1,040	1,373	993	2,317
2006	3363	1040	2323	1796	1446	3313	453	456	1,036	1,343	990	2,277
2007	3338	1019	2319	1787	1415	3274	438	441	1,014	1,349	974	2,260
2008	3155	998	2157	1686	1377	3102	436	437	992	1,250	940	2,110
2009	3003	996	2007	1592	1307	2973	430	429	992	1,162	878	1,981
2010	2902	991	1911	1543	1255	2882	432	423	989	1,111	832	1,893
Absolute change over 1976-2010	239	85	154	340	-29	250	-63	-21	90	403	-8	160
Percent change over 1976-2010	9.0%	9.4%	8.8%	28.3%	-2.3%	9.5%	-12.7%	-4.7%	10.0%	56.9%	-1.0%	9.2%

Figure 2 American Economic Association

(Hirshey et al. 2008)

Although various studies examine analyst forecasts and R&D, no existing studies have examined how R&D impacts analysts' sales and EPS estimates, nor have researcher's analyzed segmentation based on company size and industry type. This information can be very helpful for practitioners as they consider moving their companies into different industry segments or consider buying the stock of IT companies of different sizes. This quantitative study will fill this gap and contribute both to practitioners and the academic literature.

III CHAPTER 3: THEORETICAL BACKGROUND AND HYPOTHESES

Based on the previous studies in my literature synthesis, it is clear that R&D spending has an impact on what aspect of high-tech companies. Much existing literature focuses on analysts and their impact on stock price. Prior studies have shown that analysts' estimates of earnings or sales are quite close to the actual sales and earnings of the company—and hence the market reacts when analysts change their estimates. The stock's price moves on the day of an analyst's revision, especially if that analyst has maintained a strong reputation over the years in covering that sector. In their study, Kumar et al. (2009) found that buy recommendations issued by analysts on public domains help investors generate abnormal returns on the day of the recommendation, while sell recommendations show no significant negative abnormal returns.

Analysis done through this quantitative study will expand on the earlier studies and focus on the association between the R&D spending and analysts' sales and EPS estimate forecasts. This research will compare the generated results between various industries within the IT sector. It will also review the impact of R&D change on analysts' estimate forecasts based on the size of the firms. Practitioners will benefit from the findings through a better understanding of how analysts modify their estimates for different industry groupings and company sizes in the IT sector. Further, by understanding how estimates are reflected in the current year versus the next year, management can better plan their R&D spending budget to enhance the organization's future.

Hypothesis 1: A change in R&D expenditure impacts analysts' sales estimate forecasts for the current year.

Figure 3 Hypothesis 1

Hypothesis 2: A change in R&D expenditure impacts analysts' sales estimate forecasts for the next year.

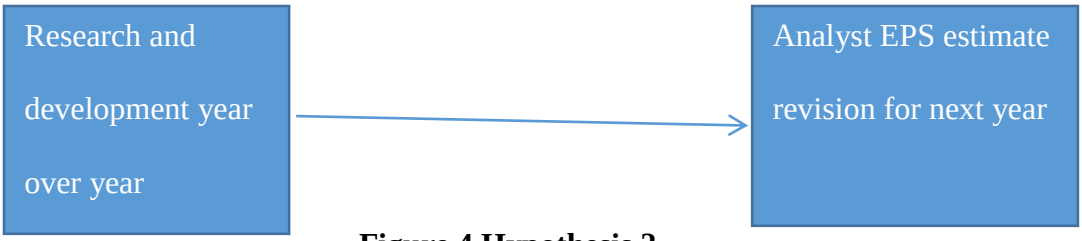

Figure 4 Hypothesis 2

Hypothesis 3: A change in R&D expenditure impacts analysts' EPS estimate forecasts for the current year.

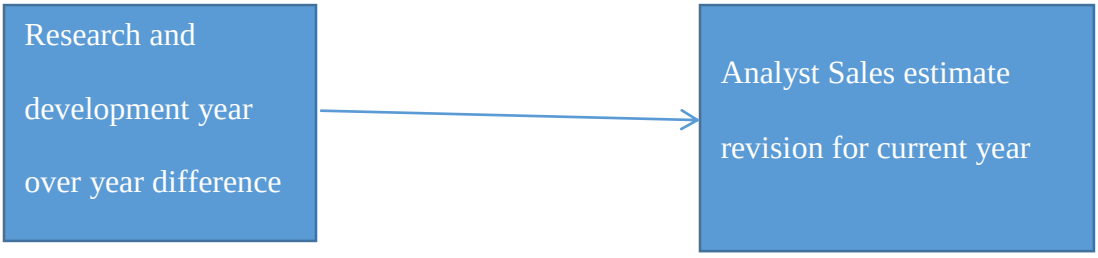

Figure 5 Hypothesis 3

Hypothesis 4: A change in R&D expenditure impacts analysts' EPS estimate forecasts for the following year.

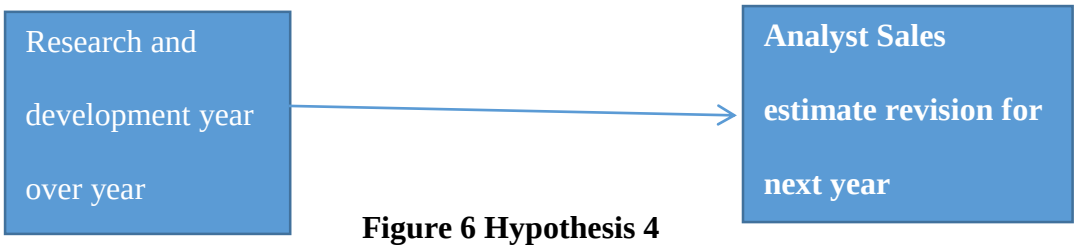

Figure 6 Hypothesis 4

This study primarily focuses on these four hypotheses, reviewing the correlation and regression results of R&D year-over-year expenditure differences associated with analysts' sales and EPS estimates for the current year and the next year. The difference between R&D expenditure from the prior to the current year is the independent variable. Analysts provide sales or EPS estimates for a company for multiple years based on the information they gather during company earning calls and/or through reports filed by the company to regulating agencies. The analysts' sales and EPS estimates for the current year and the next year are the dependent variables.

III.1 Research and Development Expense (R&D)

According to the Frasacti Manual, "Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications" (OECD, 1993).

R&D covers three activities: basic research, applied research, and experimental development. *Basic research* is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. *Applied research* is also an

original investigation, undertaken to acquire new knowledge. It is, however, directed primarily toward a specific practical aim or objective. *Experimental development* is systematic work, drawing on existing knowledge gained from research and/or practical experience and directed towards producing new materials, products, and devices; installing new processes, systems, and services; or improving substantially those already produced or installed (OECD, 1993).

R&D spending has grown sharply as a percentage of sales. In 1975, R&D expenditure stood at 1.70 percent, but it more than doubled by 1995 to 3.75 percent (Chan, Lakonishok & Sougiannis, 2001). R&D expenditure is provided by companies in their income statement, which I extracted from the WRDS database for this study.

III.2 Current Year EPS Estimate Revision

Current year EPS is defined as the company's total profit in a fiscal year, divided by the number of outstanding shares. Analysts gather this information based on the financial statements, company regulatory filing statements and by interacting with company management. Agarwal et al. (2012) found that earnings forecasts strongly respond to macroeconomic releases that signal changes in overall business conditions after controlling for analysts' learning from firm and industry-specific earnings surprises. They also found that medium-term forecasts respond much more strongly to macroeconomic news than forecasts for the current fiscal year. On average, macroeconomic surprises lead analysts to revise their current year earnings forecasts for cyclical firms by three cents and the following year's forecast by five cents. Such revisions might be made when the company's leadership changes, or when the company faces new competition.

Analysts develop expertise in obtaining and analyzing information from various sources, including the following:

- Earnings and other information from SEC filings, such as proxy statements and periodic financial reports
- Industry and macroeconomic conditions
- Conference calls and other management communications

Using this information, analysts produce earnings forecasts, target price forecasts, and stock recommendations, along with qualitative reports describing a firm's prospects. Ramnath (2002) showed that analysts revise their earnings forecasts in response to the earnings announcement of other firms in the same industry. Based on the above studies, I can confirm that analysts include specific industry and/or market sector factors in their earnings forecasts. EPS is also impacted when there is an increase in advertisement spending, as it will attract more customers. With additional customers, the firm's revenues will rise, which in turn increases the bottom line of the company.

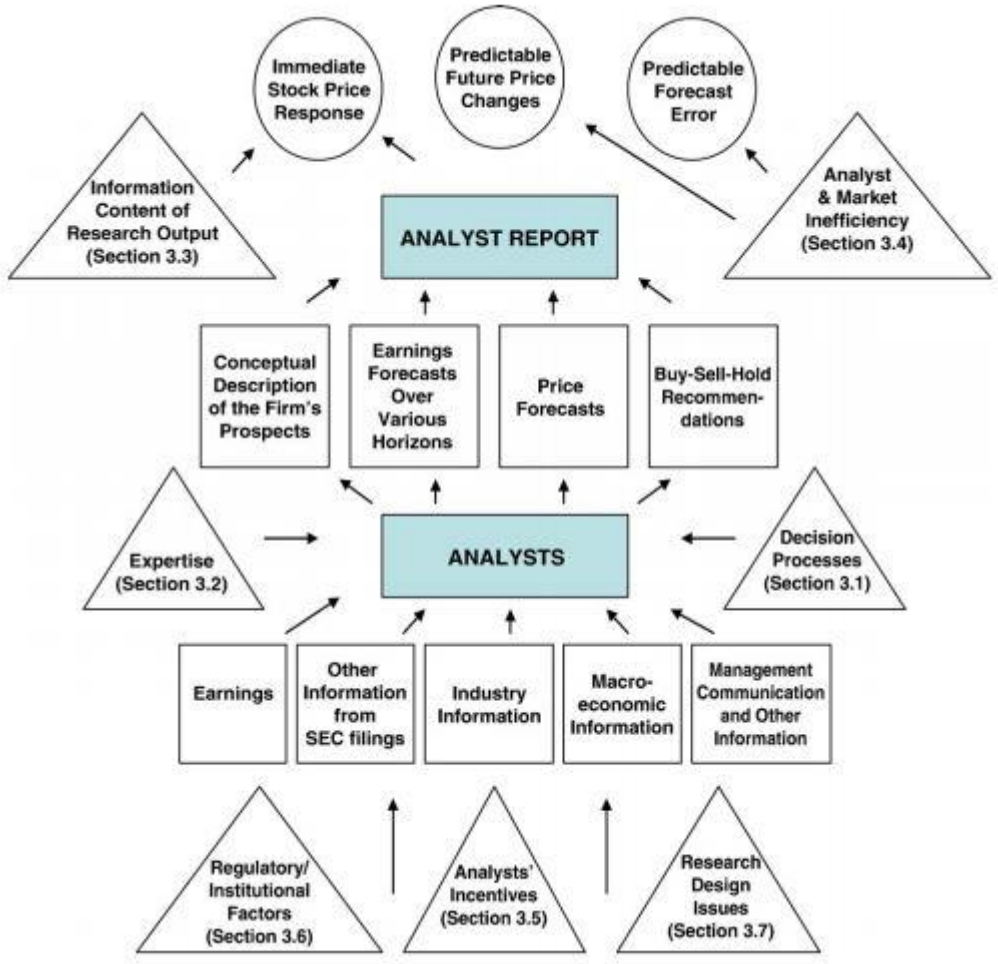

Figure 7 Input to Analyst Report

(Ramnath, Rock, Shane 2003)

III.3 Next Year EPS Estimate Revision

Next year EPS is defined as the profit a company generates per share in the following year. Analysts update this estimate at the same frequency as they update their current year EPS; the factors that impact the current year EPS estimates might also impact the next year EPS estimates. However, in some scenarios, the current year EPS might be reduced, while the next year EPS is increased. For example, a company might spend more on advertising in the current year to market a new product, reducing advertising in the year following, which will increase the EPS estimate for that following

year. Also, the next year's EPS estimate might be revised up, as the resources hired to support the new product might not be needed in the following year. As the new product stabilizes, customer support will be reduced, which improves the EPS of the organization.

III.4 Current Year Sales Estimate Revision

The current year sales forecast is defined as the company revenue that analysts predict for the current year. Analysts' forecasts and the revisions that follow influence price-relevant trades (Givoly & Lakonishok, 1979; Lys & Sohn, 1990; Park & Stice, 2000). Analysts' estimating activities should cause prices to reflect the market and industry information, resulting in larger return synchronicity (Piotroski & Roulstone 2003). Clement (1999) and Jacob, Lys, and Neale (1999) found that analyst accuracy improves with industry specialization, while Gilson et al. (2001) illustrated that the analyst coverage composition is impacted after spin-offs and equity carve-outs.

The macro economy also plays an important part in analysts' sales estimates. For example, when consumer confidence falls, people reduce their spending, which impacts a company's revenue. Also, when the companies are not hiring and wages stagnate, consumer spending also declines, which also impacts a company's sales. When jobs are impacted, people delay buying computers, software, and other technology products that impact computer manufacturers and software development companies. The same is true for corporations: companies review the outlook of the economy and decide on their spending; if the outlook is bleak, they postpone capital purchase for few years and wait for market conditions to improve. Corporate analysts thus revise their revenue forecasts for technology companies based on job market conditions, consumer confidence, and economic outlook.

Historically, the technology industry has experienced considerable disruption. Blackberry—once the leader in the smart phone industry—was replaced by Apple and Samsung, while Yahoo's leadership in search engine and email technology was usurped by Google. Analysts thus look at the industry, review the competition in various areas, and revise the revenue forecasts for companies accordingly.

III.5 Next Year Sales Estimate Revision

Analysts' next year sales estimate forecasts are defined as the revenue a company is expected to make the following year. Analysts update their estimates for the next year at the same frequency as they update their sales estimate forecasts for the current year, as factors that impact the current year's sales might also impact those of the following year. Similar to EPS, the next year's sales estimate might differ from the current year's sales estimate. New product launches or new marketing initiatives might influence next year's revenue, which in turn is captured by analysts when they estimate the next year's sales.

IV CHAPTER 4: DATA COLLECTION AND ANALYSIS

For this research, I extracted two sets of data from the WRDS website:

- R&D expenditure and company-related information
- Analyst estimate information

I extracted the R&D expenditure and company-related information from the Compustat database. Because my research focuses on the IT sector, I specifically extracted the data pertaining to this sector by querying the database with Global Industry Classification (GIC) sector code 45. I gathered the R&D/company-related data from the yearly database section, which annually consolidates this data for IT companies.

I extracted analyst estimates from the WRDS IBES database for the following categories:

- Sales estimate for the current year ("1st year" as per WRDS database)
- EPS estimate for the current year
- Sales estimate for the next year ("2nd year" as per WRDS database)
- EPS estimate for the next year

Most analysts make changes to their estimates following the company's quarterly earnings release; analysts attend the quarterly earnings release conference and ask questions needed to update their forecast estimate. Their questions typically focus on the existing quarterly results, as well as the company's forecast in terms of sales, earnings, expenditure on advertisement, and R&D. This information gives them the input needed to model their earnings estimate forecasts for sales and EPS. After gathering this information, analysts generate a detailed report about the target company. In that report, they cover the company's future sales, earnings, and ideal stock price, and offer a

recommendation to buy, sell, or hold the stock. Finally, some analysts change their estimate forecasts in the wake of macro information or changes related to the company. Although analysts publish their estimates about a target company on different days in a month, the IBES database consolidates the information on a monthly basis. Because multiple analysts cover particular stocks—typically those of large or popular companies—in a given month, multiple analysts might change their estimates. I thus use the median information for this study.

The data I collected for R&D expenditures and analyst estimates is for 20 years, from 1995 to 2014. I extracted the data in Excel format from the Compustat and IBES databases. I then cleaned the data in the Excel database before loading it into IBM Statistical Package for Social Sciences (SPSS**)**. I extracted data related to all IT companies, but not all such companies have R&D expenditures so I filtered out those companies who did not spend on R&D in the Excel spreadsheet.

Table 1 R&D and Company-Related Information

Data extracted	Description of the data.
Stock Symbol	Symbol representing the stock, (Apple, symbol will be AAPL, Microsoft MSFT)
Fiscal year	Financial year (1995, 1996….)
Company Name	Full name of the company, Apple will be Apple INC, IBM will be INTL BUSINESS MACHINES CORP
Revenue	Total revenue for the year.
Asset	Total Asset the company reported during end of their financial year in their reports.
Gross Profit	Profit company makes after deducting the costs associated with making and selling its products
R&D spending for current year	Research and development spending for the current year
R&D spending for prior year	Research and development spending for the prior year
Long-term debt	Debt obligations such as bank loans, mortgage, bonds which matures more than one year

Notes: R&D information and company-related information from Compustat database.

I calculated the following information using the data in Table 1:

- Gross margin: gross profit/revenue
- The gross margin data point (used during the regression)
- Debt-to-sales: long-term debt/revenue
- The debt-to-sales data point (used during the regression)
- Revenue difference: the revenue for the current year minus the revenue for the prior year
- Revenue difference percentage: revenue difference/revenue for prior year

Because the revenue for the prior year is not available in the WRDS, I derived it from the previous year's data using Excel advanced programming.

I generated the second set of data from the IBES database.

Table 2 Analyst Data from IBES

Data extracted from IBES database
Symbol
Period end data
Measurement (EPS or Sales)
Forecast period (1 – current year, 2 – Next year)
Median estimate

I extracted the IBES data pertaining to analyst estimates into Excel as monthly summary data, then transformed it into analysts' beginning of the year and end of the year estimates. I did this using Excel functions and pivot tables. A company's starting month and ending month are identified at the start of the data construction process; such

information varies among companies as they have different fiscal year closing months (most companies use December as the fiscal year closing month, but some use March, June, or September).

I used advanced Excel functions to calculate analyst data in four areas—current year sales percentage, next year sales percentage, current year EPS percentage, and next year EPS percentage—then merged the data with the records generated from the Compustat database. The R&D data, company data, and analyst data are normalized into a single record for each company per calendar year. For example, for IBM, there is one record per year from 1995 to 2014; this contains all the data needed for my analysis. The data massaged in Excel is then uploaded and analyzed in SPSS software.

Table 3 Data Calculated and Consolidated in Excel Spread Sheet

Data consolidated in Excel spread sheet
Analyst Sales estimate forecast for current year
Analyst Sales estimate forecast for Next year
Analyst EPS estimate forecast for current year
Analyst EPS estimate forecast for Next year
Analyst Sales estimate forecast percentage change for current year
Analyst Sales estimate forecast percentage change for Next year
Analyst EPS estimate forecast percentage change for current year
Analyst EPS estimate forecast percentage change for Next year

IV.1 Distribution of Samples over Time, by Size and by Industry

IV.1.1 Time

The data in Table 4 provides the year-wise breakup of the number of companies in each calendar year for this study. This research is a 20-year study of IT companies, with data gathered for the years 1995 to 2014. The records identified are for companies that had R&D expenses allocated in their balance sheets that were also covered by analysts. The number of companies in Table 4 for each calendar year increased from 1995 to 1999, then, following dot-com burst, the number declined, as many technology companies went bankrupt. After the dot-com crash, the market value of many companies decreased dramatically, and many were either bought by or merged with other (often larger) companies. In 2000, 526 companies IT companies had R&D allocations on their income statements and were covered by analysts. In 2013, the number declined to 327—a reduction of 199 companies over 13 years due to bankruptcy, mergers, or purchase by other companies. However, the study's final year (2014) showed a slight increase in IT companies.

Table 4 Year Wise Number of Firms

Year	No of companies in this study	Percentage
1995	301	3.8
1996	387	4.9
1997	413	5.2
1998	423	5.4
1999	462	5.8
2000	526	6.7
2001	489	6.2
2002	448	5.7
2003	407	5.2
2004	407	5.2
2005	392	5.0
2006	378	4.8
2007	398	5.0
2008	363	4.6
2009	346	4.4
2010	337	4.3
2011	339	4.3
2012	332	4.2
2013	327	4.1
2014	341	4.3

IV.1.2 Size

Market capitalization data provides company size: the larger the market capitalization, the larger the company. The firms are divided into three categories according to their market capitalization:

- Large: greater than or equal to $10 billion (USD)
- Midsized: greater than $1 billion, but less than $10 billion
- Small: less than $1 billion

I categorize the data to show how analysts capture R&D expenditure changes in their estimate forecasts. Large companies (greater than $10 billion) are covered by more analysts; typically those companies have been in business for a long time and have grown over the years. Small companies (less than $1 billion) are typically newer firms that are covered by fewer analysts.

IV.1.3 Industry

After extracting data for the IT sector using GIC sector code 45, three industry groupings emerged as identified by GIC group codes: Software and Services (which had the most records), Technology Hardware and Equipment, and Semiconductor.

Table 5 Industry Grouping

GIC group code	Description of the group
4510	Software and Services
4520	Technology Hardware and equipment
4530	Semiconductor

IV.1.3.1 Software and Services group

The Software and Services group encompasses application software, systems software, Internet software and services, data processing and outsourced services, IT consulting, and home entertainment software companies. As Table 6 shows, this group had the most records (3,074).

IV.1.3.2 Technology Hardware and Equipment

The Technology Hardware and Equipment group consists primarily of communications equipment, computer hardware, computer storage and peripherals, electronic equipment and instruments, electronic components, electronic manufacturing

services, technology distributors, and office electronics companies. This group had 2,961 records (see Table 6).

IV.1.3.3 Semiconductor

The Semiconductor group is made up of semiconductor and semiconductor equipment firms, and was once part of the Technology Hardware and Equipment group. It had the fewest number of records, with 1,863 (Table 6).

Table 6 Number of Records Industry Wide

Type of industry	No of Records	Percentage
Software and Services	3074	38.9
Technology Hardware and equipment	2961	37.5
Semiconductor	1863	23.6

Table 7 shows the industry groupings, sub-industry descriptions, and sample companies.

Table 7 Sub Industries and Company Examples.

Industry	Sub Industries description	Examples of companies in these industry
Software and Services	Internet Software & Services	Yahoo, AOL,
	IT consulting and other services	Teradata, IBM
	Data processing and outsourced services	Xerox
	Application Software	Intuit, Adobe systems
	Systems Software	Oracle, Microsoft
	Home Entertainment Software	Take-Two, Zynga
Technology Hardware & equipment	Communications Equipment	Cisco, Qualcom
	Computer Hardware	Dell
	Computer Storage and Peripherals	Apple, Sandisk
	Electronic Equipment and Instruments	Itron, Zebra technologies
	Electronic Components	Corning
	Electronic Manufacturing Services	Flextronics
	Technology distributors	Richardson electronics
	Office electronics	General Scanning
Semiconductor	Semiconductor Equipment	Lam Research, Teradyne
	Semiconductors	Texas Instrument, First solar

IV.2 Data analysis

A single record for each company per fiscal year was created in Excel and imported into SPSS to generate the results. Separate results were generated for analysts' sales

estimates and analysts' EPS estimates; to show analysts' estimate changes for current year and next year, I ran the tests separately for each of those years.

A summary of the analysis done in SPSS to generate the results is as follows:

- Descriptive statistics were generated for all variables used in this study.
- A correlation matrix was generated for all independent variables and for different market capitalization companies.
- Correlation tests were performed to identify the association between R&D spending and the changes in analysts' current year sales estimates; these tests were run for the three different industry groups and for the three different company sizes. A correlation test was also run for R&D spending increases that were greater than five percent (eight tests were performed in this category).
- Correlation tests were performed to identify the association between R&D spending and changes in analysts' next year sales estimates, as well as the above-mentioned six segment tests and those for R&D spending increases greater than five percent (eight tests were also performed in this category).
- Correlation tests were performed to identify the association between R&D spending and analysts' current year EPS estimates, along with the same six segment tests and those for R&D spending increases greater than five percent (again, eight tests were performed in this category).
- The same correlation tests were performed to identify the association between R&D spending and changes in analysts' next year EPS estimates.

- Regression tests were run on five independent variables—R&D spending differences, revenue differences, assets log, long-term debt/sales, and gross margin— association with changes in analysts' current year sales estimates. As with correlation, regression tests were run for the three industry groups and three company sizes, as well as for R&D spending increases greater than five percent. I also ran an additional test without revenue difference regression (performing nine regression tests in this category).
- Regression tests were run on the five independent variables association with changes in analysts' next year sales estimates, the six segmentation tests, R&D greater than 5 percent, and regression without revenue differences (nine tests).
- The same regression tests were performed with the above-mentioned independent variables association with changes in analysts' current year EPS estimates.
- The same regression tests were performed with the above-mentioned independent variables association with changes in analysts' next year EPS estimates.

Overall, 32 correlation and 40 regression tests were conducted to analyze the four different hypotheses in this study. The outcomes of these tests will help to determine whether the results support the four hypotheses.

V CHAPTER 5: RESULTS

V.1 Descriptive Statistics

Table 8 shows summary statistics of data gathered for 7,900 samples related to IT firms with group ID 45. The variable assets, gross profit (loss), long-term debt, revenue, gross margin, research and development current year, research and development prior year, and market value were extracted from the Compustat database. Revenue prior year, revenue difference, revenue difference percentage, R&D difference, and R&D difference percentage were calculated.

I extracted analysts' current and next year EPS estimates from the end and the beginning of each year from the IBES database. I extracted the same data for analysts' sales estimates from IBES. The actual difference and the difference in percentage variables for EPS and sales were calculated in Excel before uploading the values into SPSS.

Table 8 Descriptive Statistics

	Minimum	Maximum	Mean	Std. Dev
Assets – Total	0.03	290479.00	1990.70	10510.24
Gross Profit (Loss)	-719.76	104126.00	756.84	4213.38
Long-term debt	0.00	39959.00	232.63	1572.32
Revenue				
Revenue current year	0.00	233715.00	1430.16	7936.83
Revenue Prior year	0.00	182795.00	1518.93	7873.99
Revenue difference	-12519.00	50920.00	114.47	1293.41
Revenue difference percentage	-1.00	65.87	0.20	1.14
Gross Margin	-141.41	1.00	0.38	3.49
Market Value - Total - Fiscal	0.60	626550.35	5072.62	28018.82
Research & Development				
Research & Development Expense	0.00	12128.00	146.98	675.72
Research & Development Prior year	0.00	11537.00	134.53	629.37
Research spending difference	-1595.00	2209.00	12.45	94.22
Research difference percentage	-1.00	345.84	0.36	4.31
Analyst estimate current year EPS end of the year	-645.00	53.20	0.00	9.33
Analyst estimate current year EPS beginning of the year	-510.00	57.00	0.32	7.04
Analyst estimate current year EPS difference	-318.20	27.75	-0.32	5.00
Analyst estimate current year EPS difference %	-116.25	205.00	-0.18	4.75

Analyst estimate next year EPS end of the year	-141.43	58.50	0.61	3.52
Analyst estimate next year EPS beginning of the year	-276.57	75.60	0.84	4.88
Analyst estimate next year EPS difference	-106.41	188.00	-0.23	3.60
Analyst estimate next year EPS difference %	-81.00	63.00	-0.20	2.56
Analyst estimate current year sales end of the year	0.00	233139.50	1597.31	8441.96
Analyst estimate current year sales year beginning of the year	0.00	210730.00	1616.93	8447.77
Analyst estimate current year sales difference	-22608.30	22409.50	-19.63	780.76
Analyst estimate current year sales difference %	-1.00	14.00	-0.02	0.30
Analyst estimate next year sales current year end of the year	0.00	245433.00	1775.64	9216.57
Analyst estimate next year sales current year beginning of the year	0.60	224865.00	1844.63	9340.82
Analyst estimate next year sales difference	-85452.37	33495.50	-68.99	1726.58
Analyst estimate next year sales difference %	-1.00	5.87	-0.03	0.29
logofassets	-3.38	12.58	5.53	1.74
Long-term debt/sales	0.00	2.03	0.07	0.13

V.2 Correlation Matrix of Independent Variables

I generated the correlation matrix for all the variables used in the regressions. The matrix shows which independent variables are strongly correlated and which are not correlated. As Table 9 shows, the research difference percentage is strongly correlated with the revenue difference percentage. The correlation between research spending difference and revenue difference is .205, with .000 significance.

Table 9 Correlation Matrix for All Independent Variables

Correlations matrix						
		Research difference percentage	Long-term debt/sales	Revenue difference percentage	Log of Assets	Gross Margin
Research spending difference in percentage (year over year)	Pearson Correlation	X	-.011	.205	-.018	-.005
	Sig. (2-tailed)		.317	.000	.117	.651
	N	7898	7767	6650	7898	7881
Long-term debt/sales	Pearson Correlation	-.011	X	-.019	.221	-.004
	Sig. (2-tailed)	.317		.122	.000	.746
	N	7767	7767	6562	7767	7753
Revenue difference percentage (year over year)	Pearson Correlation	.205	-.019	X	-.012	-.026
	Sig. (2-tailed)	.000	.122		.336	.033
	N	6650	6562	6650	6650	6647
Log of Assets	Pearson Correlation	-.018	.221	-.012	X	.073
	Sig. (2-tailed)	.117	.000	.336		.000
	N	7898	7767	6650	7898	7881
Gross Margin	Pearson Correlation	-.005	-.004	-.026	.073	X
	Sig. (2-tailed)	.651	.746	.033	.000	
	N	7881	7753	6647	7881	7881

Notes : Correlation Matrix between all independent variables used in regression.

In Table 10, the correlation matrix shows the results generated for the companies with market capitalization greater than or equal to $10 billion. As with Table 9's results, the research difference percentage is strongly correlated with the revenue difference percentage. The correlation between research spending difference and revenue difference is .586, with .000 significance. This is much higher than the correlations for the sample at large, indicating that large companies exhibit a very strong relationship between R&D and sales changes. All other independent variables are negatively correlated to the research difference percentage.

Table 10 Correlation Matrix for Large Size Firms

Correlations Matrix for market value >= 10 billion						
		Research difference percentage	Long-term debt/sales	Revenue difference percentage	Log of Assets	Gross Margin
Research spending difference in percentage (year over year)	Pearson Correlation	X	-.122	.586	-.321	-.095
	Sig. (2-tailed)		.013	.000	.000	.051
	N	424	412	413	424	424
Long-term debt/sales	Pearson Correlation	-.122	X	.030	.176	-.076
	Sig. (2-tailed)	.013		.555	.000	.121
	N	412	412	401	412	412
Revenue difference percentage (year over year)	Pearson Correlation	.586	.030	X	-.366	.116
	Sig. (2-tailed)	.000	.555		.000	.018
	N	413	401	413	413	413
Log of Assets	Pearson Correlation	-.321	.176	-.366	X	-.085
	Sig. (2-tailed)	.000	.000	.000		.079
	N	424	412	413	424	424
Gross Margin	Pearson Correlation	-.095	-.076	.116	-.085	X

	Sig. (2-tailed)	.051	.121	.018	.079	
	N	424	412	413	424	424

In Table 11, the correlation matrix illustrates the results for companies with less than $10 billion and more than $1 billion in market capitalization. Similar to large companies, the research difference percentage is strongly correlated with the revenue difference percentage. The correlation between research spending difference and revenue spending is .627.

Table 11 Correlation Matrix for Medium Size Firms

Correlations Matrix for Market value > 1 billion and < 10 billion						
		Research difference percentage	Long-term debt/sales	Revenue difference Percentage	Log of Assets	Gross Margin
Research spending difference in percentage (year over year)	Pearson Correlation	X	-.092	.627	-.201	-.069
	Sig. (2-tailed)		.000	.000	.000	.004
	N	1716	1693	1580	1716	1716
Long-term debt/sales	Pearson Correlation	-.092	X	-.095	.298	-.017
	Sig. (2-tailed)	.000		.000	.000	.487
	N	1693	1693	1558	1693	1693
Revenue difference percentage (year over year)	Pearson Correlation	.627	-.095	X	-.269	-.107
	Sig. (2-tailed)	.000	.000		.000	.000
	N	1580	1558	1580	1580	1580
Log of Assets	Pearson Correlation	-.201	.298	-.269	X	-.023
	Sig. (2-tailed)	.000	.000	.000		.336
	N	1716	1693	1580	1716	1716
Gross Margin	Pearson Correlation	-.069	-.017	-.107	-.023	X
	Sig. (2-tailed)	.004	.487	.000	.336	
	N	1716	1693	1580	1716	1716

In Table 12, the correlation matrix shows results for companies with market capitalization that is less than or equal to $1 billion. Although these results show that the research difference percentage is correlated with revenue difference percentage, the correlation is not as strong as it is for companies with more than $1 billion in market capitalization. The correlation between research spending difference and revenue spending is .167 although this is much lower than in large companies. All other independent variables are not significant at normal levels.

Table 12 Correlation Matrix for Small Size Firms

Correlations Matrix for Market value <= 1 billion						
		Research difference percentage	Long-term debt/sales	Revenue difference Percentage	Log of assets	Gross Margin
Research spending difference in percentage (year over year)	Pearson Correlation	X	-.016	.167	.001	-.016
	Sig. (2-tailed)		.294	.000	.969	.280
	N	4473	4399	3894	4473	4458
Long-term debt/sales	Pearson Correlation	-.016	X	-.010	.190	-.005
	Sig. (2-tailed)	.294		.536	.000	.727
	N	4399	4399	3849	4399	4387
Revenue difference percentage (year over year)	Pearson Correlation	.167	-.010	X	.009	-.026
	Sig. (2-tailed)	.000	.536		.566	.100
	N	3894	3849	3894	3894	3891
Log of Assets	Pearson Correlation	.001	.190	.009	X	.095
	Sig. (2-tailed)	.969	.000	.566		.000
	N	4473	4399	3894	4473	4458
Gross Margin	Pearson Correlation	-.016	-.005	-.026	.095	X
	Sig. (2-tailed)	.280	.727	.100	.000	
	N	4458	4387	3891	4458	4458

I analyzed sales estimate forecasts and research spending, then followed the same procedure for the EPS estimates. Within the sales tests, I analyzed both the current year and the following year. The tests were initially focused on all IT companies; I then drilled down into market size and industry segments.

V.3 Hypothesis 1: A change in R&D expenditure impacts analysts' sales estimate forecasts for the current year.

To test this hypothesis, a correlation test was performed between the R&D spending difference percentage and the analysts' sales estimates difference percentage for the current year (see Table 13).

Table 13 Correlation R&D and Analyst Sales Estimate

Years	Sector description	Pearson Correlation	Sig	N
Current year estimate	All IT companies	.153	.000	6830
Next year estimate	All IT companies	.183	.000	6690

Notes: Correlation of Analyst Sales estimate percentage difference (dependent variable) with R & D expenditure percentage difference (independent variable)

As Table 13 shows, there is a positive correlation between R&D expenditure and analysts' sales estimates for the current year. The Pearson correlation is .153, with .000 significance (Table 13); the number of records used for the current year analysis was 6,830. Based on the correlation results, Hypothesis 1 is supported.

V.4 Hypothesis 2: A change in R&D expenditure impacts analysts' sales estimate forecasts for the next year.

To test this hypothesis, I performed correlation analysis for the next year (Table 13). The results show a correlation between R&D expenditure and analysts' sales estimates. The Pearson correlation is .183, with .000 significance; the number of records used for the next year analysis was 6,690. Based on the correlation results, Hypothesis 2 is also supported.

Although the correlation tests support hypotheses 1 and 2, I conducted regression tests to confirm whether changes in R&D have a major influence on changes to analysts' sales estimates. I executed the regression tests using the five independent variables—R&D expenditure difference percentage, gross margin, log of assets, revenue difference, and long-term debt/sales—with the dependent variable being analysts' sales estimate percentage difference.

Table 14 Regression of R&D, Revenue, … with Analyst Sales Estimate

Years	R^2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.075	.000	98.09	.221/.000	.006/.607	.095/.000	.092/.000	-.015/.242
Next year estimate	.069	.000	87.99	.159/.000	.005/.686	.123/.000	.142/.000	-.007/.575

Notes : Regression of Independent variables (R&D expenditure percentage difference, Ratio of gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst sales estimate percentage difference (dependent variable).

For the current year, the R^2 value is .07; reviewing the standards coefficient beta values shows that research spending difference has the highest influence in the regression with .221 and .000 significance (Table 14). The revenue difference percentage standard coefficient beta value is .092, with .000 significance, and the asset log is .095, with .000 significance, which illustrates that these independent variables also influence the regression. Other independent variables did not prove significant in this regression.
For the next year, the regression results (Table 14) are quite similar to the current year, with R^2 at .069. In the next year results, research spending is the highest contributing independent variable: .159, with .000 significance. Similar to the current year, in the next year, both revenue difference and assets have a positive coefficient beta value, with .000 significance.

I further analyzed the analysts' sales estimate percentage difference and R&D expenditure percentage difference based on company size. For all three categories, the current year and next year correlations are positive and the significance is .000 (see Table 15). For companies with $10 billion or more in market value for the current year, the correlation is quite strong: .569, with .000 significance and a sample size of 421. The sample size increases for companies with less than $10 billion in market capitalization; it increases even more for companies with less than $1 billion in market capitalization. For current year analyst sales estimates for companies with market capitalization of more than $1 billion and less than $10 billion, the correlation is .350 with a significance of .000

and a sample size of 1,685. For companies with less than $1 billion in market capital, the current year correlation is not as strong as in other results, but still has a positive correlation of .128, with significance of .000 and a sample size of 4,502.

The correlation for analysts' next year sales estimate differences and the R&D spending differences follows a pattern identical to the current year results. The correlation is stronger for larger market capitalization companies. The next year results reveal that, for companies with $10 billion in market value, the correlation is strong: .479, with .000 significance. The sample size for this analysis is 421 (the sample size increases as the market value decreases, similar to the current year pattern). For companies with market capitalization greater than $1 billion and less than $10 billion for the next year, the correlation is .361, with a .000 significance and a sample size of 1,674. For firms with a market capitalization of less than $1 billion, the correlation between the analysts' next year sales estimates and the R&D spending difference is not as strong as in other segments: the correlation value is .128, with .000 significance and a sample size of 3,969.

Table 15 Correlation of R&D with Analyst Sales – Market Cap Segmentation

Years	Market value	Pearson Correlation	Sig	N
Current year estimate	>=10 billion	.569	.000	421
Current year estimate	>1 billion & <10billion	.350	.000	1685
Current year Estimate	=< 1 billion	.128	.000	4502
Next year Estimate	>=10 billion	.479	.000	421
Next year Estimate	>1 billion & <10billion	.361	.000	1674
Next year Estimate	=< 1 billion	.102	.000	3969

Notes: Market cap wise correlation of Analyst Sales estimate percentage difference (dependent variable) with R & D expenditure percentage difference (Independent variable).

Positive correlation exists for all results in Table 15; to confirm that R&D expenditures are the major influencer for analysts to update their sales estimate, regression tests were performed. The regression results in Table 16 demonstrate that R^2 is 65 percent, but that research spending is not significant in this regression. Other values also are not significant in this regression, apart from the revenue difference percentage, which had a strong coefficient value of .839. The same pattern is observed in the next year estimate results: R^2 is 37 percent, the research spending standard coefficient beta is –.009, with .851 significance. The results show that, in the current year, the revenue percentage difference's standard coefficient beta is .636, with .000 significance.

Table 16 Regression of R&D, Revenue, … with Analyst Sales Estimate (Large Size companies)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.657	.000	150.2	-.020/.583	-.024/.434	.047/.151	.839/.000	.020/.513
Next year estimate	.379	.000	47.95	-.009/.851	-.030/.468	.047/.285	.636/.000	.034/.400

Notes : Regression of independent variables (R&D expenditure percentage difference, Ratio of gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst Sales estimate difference percentage for companies with market capitalization >= 10 billion.

As Table 17 shows, for companies with market capitalization greater than $1 billion and less than $10 billion, the results are similar to companies with market capitalization greater than $10 billion. In Table 17, R^2 is 49 percent with an F value of 299, but research spending is negatively correlated, with significance higher than .005. The other variables in this regression are not significant, apart from revenue difference percentage, which is significant with the coefficient value of .722.

The same pattern occurs in the next year estimate results (Table 17), where R^2 is 65 percent; the research spending standard coefficient beta is not significant, but the revenue percentage difference standard coefficient beta is .636, with .000 significance.

Table 17 Regression of R&D, Revenue, … with Analyst Sales Estimate (Medium Size companies)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.493	000	299.5	-.037/120	-.055/.004	-.009/.641	.722/.000	.027/.181
Next year estimate	.649	.000	222	.016/.524	-.104/.000	.006/.772	.622/.000	.012/.568

Notes : Regression of independent variables (R&D expenditure percentage difference, Ratio of gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst Sales estimate difference percentage for companies with market capitalization < 10 billion and market capitalization > 1 billion.

The pattern changes for companies with market capitalization of $1 billion or less. In this segment, the research spending estimate difference has the highest standard coefficient beta value of the independent values at .217, with a .000 significance. The value for next year research spending estimate difference standard coefficient beta is .103. In both current year and next year, the R^2 is .05 and .02, respectively, and the F values are 42.20 and 16.8, respectively, with .000 significance. Gross margin and long-term debt sales values (Table 18) are not significant, and revenue difference percentage is significant only in the next year results section. Assets values are significant at .059 for the current year and .068 for the next year.

Table 18 Regression of R&D, Revenue, … with Analyst Sales Estimate (Small size companies)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.055	.000	42.20	.217/.000	.003/.863	.059/.000	.029/.079	-0.14/.381
Next year estimate	.024	.000	16.8	.103/.000	.001/.955	.068/.000	.074/.000	-.011/.534

Notes : Regression of independent variables (R&D expenditure percentage difference, Ratio of gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst Sales estimate difference percentage for companies with market capitalization < 1 billion.

Table 19 shows the analysts' sales estimates percentage difference compared to the R&D expenditure difference based on the IBES database's three GIC industry groupings: Software and Services, Technology Hardware and Equipment, and Semiconductor. As in all three company size categories, for current year and next year the correlation is positive for all three industry groups, with a .000 significance. For Software and Services firms, the correlation is strong and significant with .210 and the sample size of 2,719.

The sample size is the largest for Software and Service group. Correlation results for Technology and Hardware companies for the current year analyst sales estimate difference compared to R&D expenditure difference is .088, with .000 significance and a

sample size of 2,458. The sample size for the current year Semiconductor category is 1,683—the smallest of the three sectors—yet the correlation is still significant at .136.

The next year's results for the industry groups demonstrate the association of analysts' sales estimate percentage difference to R&D expenditure difference: the correlation for Software and Services is .205, with .000 significance and a sample size of 2,657. For Technology Hardware and Equipment, the correlation with the same constructs is .211, with .000 significance and a sample size of 2,369. As with the current year, the sample size is lowest for the semiconductor group at 1,664, with a .120 correlation.

Table 19 Correlation of R&D with Analyst Sales – Industry Group Segmentation

Years	Market value	Pearson Correlation	Sig	N
Current year estimate	Software and Services (4510)	.210	.000	2719
Current year estimate	Technology Hardware and equipment (4520)	.088	.000	2458
Current year estimate	Semiconductor and Semiconductor equipment(4530)	.136	.000	1683
Next year estimate	Software and Services (4510)	.205	.000	2657
Next year estimate	Technology Hardware and equipment (4520)	.211	.000	2369
Next year estimate	Semiconductor and Semiconductor equipment(4530)	.120	.000	1664

Notes: Industry wise correlation of Analyst Sales estimate percentage difference (dependent variable) with R & D expenditure percentage difference (independent variable).

Table 20's regression results for Software and Services shows that R^2 is .08, but the research spending standard coefficient beta is positive at .235, with significance below .01. For the revenue difference percentage and assets log, the coefficient values are both significant at .106 and .057. The next year results are identical to the current year

results, where R^2 is .11 with an F value of 60.11 and .000 significance. The research spending standard coefficient beta is positive at .168, while the revenue difference and assets log are at .229 and .130, respectively, and all three values have a significance of less than .01. Other values are not significant in this regression.

Table 20 Regression of R&D…… with Analyst Sales Estimate (Software & Services)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.083	.000	41.92	.235/.00	.004/.860	.057/.005	.106/.000	.001/.960
Next year estimate	.118	.000	60.11	.168/.00	.008/.697	.130/.000	.229/.000	.007/.734

Notes: Regression of independent variables (R&D percentage difference, Ratio of gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst sales estimate percentage difference (dependent variable) for Software and Service industry group.

In the Hardware and Equipment group, the regression results illustrate that the standard coefficient beta for the current year is .195; for the next year, the value is the same, with a .000 significance for both years. The analysis for current year results showed no significance value for revenue difference, but the gross margin and asset log values are significant, with coefficient values of .061 and .025, respectively. Results for

the next year reveal that, apart from research spending and long-term debt/sales, all other values are not significant.

Table 21 Regression of R&D…… with Analyst Sales Estimate (Technology Hardware)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.073	.000	34.48	.195/.000	.061/.004	.159/.000	.025/.227	-.001/.962
Next year estimate	.60	.000	27.09	.195/.000	.045/.035	.113/.000	.044/.041	.027/.218

Notes: Regression of independent variables (R&D percentage difference, Ratio of gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst sales estimate percentage difference (dependent variable) for Technology Hardware industry group.

Finally, in the Semiconductor Equipment group (Table 22), the results show that research spending values are not significant. In both years, the revenue difference has a significant standard coefficient value of .494 and .390. The R^2 is 51 percent for the current year and 16 percent for next year.

Table 22 Regression of R&D……with Analyst Sales Estimate (Semiconductor)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.516	.000	112.8	-0.43/.064	.08/.000	.117/.000	.494/.000	-.038/.092
Next year estimate	.166	.000	61.16	-0.19/.436	.007/.769	.119/.000	.390/.000	.030/.217

Notes: Regression of independent variables (R&D percentage difference, Ratio of gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst sales estimate percentage difference (dependent variable) for semiconductor industry group.

The correlation and regression results for the analysts' sales estimate percentage difference compared to the R&D percentage difference primarily shows a positive correlation; a few results are negative in regression but not significant. The next few tables show results for analysts' EPS estimate revisions for the current year and the next year; these results were gathered using correlation and regression tests.

For EPS, I applied a filter on the analysts' EPS estimate percentages that were greater than –100 percent or less than 100 percent to avoid data outliers. Also, a few records had more than 9,000 percent positive or negative differences. These high percentage differences were due to the EPS estimate change from a negative value at the beginning of the year to a positive value at the end of the year, or vice versa. Filtering

greater than –100 percent and less than 100 percent removed these extreme values and reduced the data sample size by 5 percent.

V.5 Hypothesis 3: A change in R&D expenditure impacts analysts' EPS estimate forecasts for the current year.

The correlation results (Table 23) for all IT companies between analysts' EPS estimate differences and R&D differences do not show a significant value for the current or next year; the current year sample is 6,387 and its correlation is positive at .008, but it is not significant (the significance value is .536).

Table 23 Correlation R&D with Analyst EPS Estimate

Years	Sector description	Pearson Correlation	Sig	N
Current year estimate	All IT	.008	.536	6387
Next year estimate	All IT	.021	.084	6515

Notes: Correlation of Analyst EPS estimate percentage difference (dependent variable) with R & D percentage difference (independent variable) filtered on Analyst EPS estimate percentage > -100 and Analyst EPS estimate percentage < 100%.

V.6 Hypothesis 4: A change in R&D expenditure impacts analysts' EPS estimate forecasts for the following year.

The correlation results (Table 23) are positive for the next year estimate, with a coefficient value at .021; the significance is slightly above .05, with a sample size of 6,515. Although results for the next year are better than the current year, the hypothesis cannot be confirmed as the significance is greater than .05.

Similar to the regression test for analyst sales estimate forecasts to confirm the correlation results, regression tests were performed for analyst EPS estimate differences as the dependent variable and R&D expenditure difference, gross margin, assets log, revenue difference, and long-term debt/sales as the independent variables.

The regression results (Table 24) for all IT companies using R&D difference, gross margin, asset logs, revenue difference, and long-term debt/sales associated with analysts' EPS estimate differences show that research spending standard coefficient beta is negative, but the value is not significant. The revenue difference has the highest positive standard coefficient beta value, with .000 significance.

Table 24 Regression of R&D, Revenue, … with Analyst EPS Estimate

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.023	.000	24.15	-.023/.113	-.011/.000	.093/.000	.124/.000	-.011/.431
Next year estimate	.072	.000	83.86	-.035/.013	-.027/.037	.131/.000	.246/.000	-.021/.116

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100%.

We removed revenue difference from the regression testing to understand research spending's influence on the regression in the absence of the revenue difference variable. As Table 25 shows, the standard coefficient beta value was positive but not significant. The next year estimate is .023, with .06 significance, and the R^2 values are quite small.

Table 25 Regression of R&D, … with Analyst EPS Estimate (Without Revenue)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Long-term debt/Sales
Current year estimate	.005	.000	7.220	.009/.493	-.017/.191	-.014/.263	-.014/.263
Next year estimate	.010	.000	15.89	.023/.060	-.016/.197	.099/.000	-.028/.029

Notes : Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Long-term debt/sales) with Analyst EPS estimate percentage difference(dependent variable) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100%

I conducted market segmentation analysis to understand how analysts' EPS estimate difference is associated with R&D difference for various market sizes. As noted earlier, the data was filtered for analysts' EPS estimate percentage difference greater than –100 percent and less than 100 percent. The current year results illustrate (Table 26) that the correlation is positive and significant for large and midsized companies, with .134 and .050, respectively; for companies with less than $1 billion in market capitalization, the correlation is not significant.

However, reviewing results for the next year shows a standard coefficient beta value of .223 for large, .133 for medium, and .055 for small companies, and a significance value for all three segments of less than .01 with the next year analyst EPS estimate as an independent variable. The current year sample sizes for large, medium, and small companies are 404, 1,533, and 3,370, respectively, with next year sample sizes of 405, 1,558, and 3,425, respectively.

Table 26 Correlation of R&D with Analyst EPS – Market Cap Segmentation

Years	Market value	Pearson Correlation	Sig	N
Current year Estimate	>=10 billion	.134	.007	404
Current year Estimate	>1 billion & <10billion	.050	.051	1533
Current year Estimate	=< 1 billion	.013	.457	3370
Next year Estimate	>=10 billion	.223	.000	405
Next year Estimate	>1 billion & <10billion	.133	.000	1558
Next year Estimate	=< 1 billion	.055	.001	3425

Notes: Market capitalization wise Correlation of Analyst EPS estimate percentage difference(dependent variable) with R & D percentage difference (independent variable) filtered on Analyst EPS estimate percentage difference > -100% and < 100%.

Regression results for large companies (Table 27) show R^2 at 11 percent for current year and 9 percent for next year. The standard coefficient beta value for research spending is negative and not significant; the revenue difference standard coefficient beta is .386 and .384 for the current and next year, respectively, with less than .01 significance.

Table 27 Regression of R&D, Revenue, … with Analyst EPS Estimate (Large Size companies)

Years	R^2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.119	.000	10.24	-.076/.222	-.048/.328	.008/.886	.386/.000	-.017/.726
Next year estimate	.095	.000	7.975	-.004/.953	-.049/.331	-.028/.573	.304/.000	-.013/.815

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for companies with market capitalization > 10 billion.

The regression test (Table 28) was performed using four constructs: research spending difference, gross margin, assets log, and long-term debt/sales; revenue difference was not included as it had a strong influence in the previous regression test. The results from the regression without the revenue difference reveal that R^2 for the current and next year is 2 percent and 5 percent, respectively. The research difference standard coefficient beta for companies with market capitalization of more than $10 billion has positive values of .114 and .206 for the current and next year, respectively**.** The significance for both years is less than .05 mean, while other independent variables in this regression have significance greater than .05.

Table 28 Regression of R&D, … with Analyst EPS Estimate, Large Size companies (No Revenue)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Long-term debt/Sales
Current year estimate	.022	.075	2.142	.114/.036	.035/.491	-.068/.209	.001/.986
Next year estimate	.053	.000	5.470	.206/.000	.029/.563	-.049/.353	-.029/.563

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for companies with market capitalization >= 10 billion.

Midsized companies regression results (Table 29) follow the same pattern as large companies: standard coefficient beta value for research spending is negative and not significant, whereas the revenue difference standard coefficient beta is at .386 and .384 for the current and next year, respectively**,** with significance less than .01. The R^2 for the current year and next year are .02 and .05 respectively. The gross margin is positive, with a significance value of less than .05.

Table 29 Regression of R&D, Revenue, … with Analyst EPS Estimate (Medium Size companies)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.069	.000	20.42	-.132/.000	.069/.014	-.060/.038	.284/.000	-.049/.067
Next year estimate	.150	.000	50.22	-.138/.000	.116/.000	-.022/.423	.449/.000	-.003/.912

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for companies with market capitalization < 10 billion and market capitalization > 1 billion.

Results without revenue difference for midsized companies indicate (Table 30) that research spending for the current year is not significant; however, the standard coefficient of research spending for next year is significant, with the coefficient value at .106. The R^2 is weak when regression is run without the revenue difference: the R^2 is 2 percent and 3 percent for the current and next year, respectively.

Table 30 Regression of R&D... with Analyst Sales Estimate, (Medium Size companies)(No Revenue)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Long-term debt/Sales
Current year estimate	.022	.000	8.292	.026/.329	.024/.35	-1.697/.09	-.045/.090
Next year estimate	.039	.000	15.71	.106/.000	.031/.21	-.146/.000	.003/.921

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for companies with market capitalization < 10 billion and market capitalization > 1 billion.

The last category for the regression study under the market capitalization is for small market capitalization companies (Table 31). The regression results pattern is the same here as for large and midsized companies: the standard coefficient values of research spending are negative, with significance slightly above .05 for the current and next years. As in the results for the large and midsized companies, the revenue difference standard coefficient beta value is positive, with a significance of less than .01.

Table 31 Regression of R&D, Revenue, … with Analyst EPS Estimate (Small Size companies)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.014	.000	7.882	-.036/.063	-.010/.578	-.061/.002	.101/.000	.028/.146
Next year estimate	.042	.000	25.76	-.036/.056	-.042/.021	-.018/.332	.209/.000	-.005/.787

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for companies with market capitalization <= 1 billion.

In Table 32, the regression results without revenue difference for small companies demonstrate that the R^2 and F values are weak for both years. The research spending standard coefficient beta is .05, with significance less than .01; however, for the current year, the results are not significant.

Table 32 Regression of R&D… with Analyst EPS Estimate (Small Size companies) (No Revenue)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Long-term debt/Sales
Current year estimate	.006	.001	4.605	.011/.521	-.015/.393	-.071/.000	.023/.189
Next year estimate	.004	.000	3.706	.054/.002	-.022/.200	-.026/.140	-.007/.682

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for companies with market capitalization <= 1 billion.

The next set of results is based on industry grouping. I performed correlation tests to understand the association of R&D spending with analysts' EPS estimate revisions and how the results vary for different industry groups. Correlation results for sales demonstrated a positive correlation, with a significance of less than .01. However, reviewing the EPS results (Table 33) shows that only the Semiconductor industry grouping has a positive correlation of .078 for the current year and .017 for the next year, with a significance of less than .05. The other industry results show positive correlation, but with a significance value that is greater than .05.

Table 33 Correlation of R&D with Analyst EPS – Industry Group Segmentation

Years	Market value	Pearson Correlation	Sig	N
Current year Estimate	Software and Services (4510)	.014	.486	2555
Current year Estimate	Technology Hardware and equipment (4520)	.004	.844	2388
Current year Estimate	Semiconductor and Semiconductor equipment(4530)	.078	.003	1475
Next year Estimate	Software and Services (4510)	.036	.072	2568
Next year Estimate	Technology Hardware and equipment (4520)	.017	.390	2476
Next year Estimate	Semiconductor and Semiconductor equipment(4530)	.110	.000	1492

Notes: Industry wise Correlation of Analyst EPS estimate percentage difference (dependent variable) with R & D percentage difference (independent variable) Analyst EPS estimate % > -100% and Analyst EPS estimate < 100%.

The next six tables (34 to 39) show regression results of analysts' EPS estimate percentage difference based on industry segmentation. As with other EPS tests, the data is filtered by analysts' EPS estimate to avoid the outliers with extreme values. The same pattern is observed in research spending, with a negative standard coefficient beta value for the Software and Services industry group for both years and values that are not

significant (Table 34). The revenue difference standard coefficient is positive at .115 and .214 for the current year and next year, respectively, with less than .01 significance. The R^2 values are 2 percent and 6 percent for the current and next years, respectively, whereas F values are 8 and 28, respectively.

Table 34 Regression of R&D……with Analyst EPS Estimate (Software and Services companies)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.021	.000	8.46	-.028/.226	-.004/.873	.094/.000	.115/.000	.001/.949
Next year estimate	.066	.000	28.89	-.035/.139	-.049/.021	.145/.000	.214/.000	.035/.114

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for software and services industry group.

Software and Services regression results without revenue difference (Table 35) reveal that the research spending standard coefficient for next year is positive at .044, with significance below .05. The current year result is not significant even though values are positive. The R^2 values are quite weak for both years, and the F values are 2 and 11 for the current and next year.

Table 35 Regression of R&D……with Analyst EPS Estimate (Software and service companies) (No Revenue)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Long-term debt/Sales
Current year estimate	.005	.000	2.976	.015/.446	-.012/.555	.067/.001	.003/.882
Next year estimate	.018	.000	11.20	.044/.026	-.041/.039	.115/.000	.024/.000

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for software and services industry group.

Technology Hardware and Equipment regression results reveal a negative standard coefficient for research spending, which is significant as the values are less than .01 for the current year and .06 for the next year. Revenue difference is positive at .150 and .260 for the current and next year, with less than .01 significance. The R^2 values are 2 percent and 8 percent for the current and next year, respectively, and the F values are 11 and 35, respectively.

Table 36 Regression of R&D……with Analyst EPS Estimate (Technology Hardware companies)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.029	.000	11.4	-.067/.006	-.031/.167	.103/.000	.150/.000	-.007/.763
Next year estimate	.080	.000	35.89	-.043/.060	-.002/.916	.133/.000	.260/.000	.133/.000

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for technology hardware industry group.

In Table 37, results without the revenue spending difference for Technology Hardware and Equipment companies' show that the standard coefficient is not significant. In this regression, the assets log seems to have a positive standard coefficient with a significance of less than .05. Similar to other regressions without revenue, the R^2 values are 1 percent or less for both years.

Table 37 Regression of R&D……with Analyst EPS Estimate (Technology hardware companies) (No Revenue)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log assets /Sig	Long-term debt/Sales
Current year estimate	.005	.018	2.969	.004/.851	-.022/.284	.071/.001	-.013/.539
Next year estimate	.014	.000	8.542	.018/.362	.018/.374	.101/.000	-.07/.001

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for technology hardware industry group.

Semiconductor Equipment regression results (Table 38) also have revenue difference as a strong influence, with the standard coefficient at .306 and .284 for the current year and the next year, respectively, and a significance of less than .01. The research spending values are not significant for both years and the R^2 value is 9 percent for both years.

Table 38 Regression of R&D……with Analyst EPS Estimate (Semiconductor companies)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.091	.000	25.73	-.048/.093	-.05/.062	-.027/.330	.306/.000	.081/.004
Next year estimate	.090	.000	25.99	-.015/.596	-.028/.286	.119/.000	.284/.000	-.029/.291

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for semiconductor industry group.

Regression results for the Semiconductor industry group without the revenue spending difference show a positive standard coefficient value for research spending, with a significance of less than .01. The research spending has the most influence in these regression results, with standard coefficient values at .075 and .116 for the current and next year, respectively. When compared with other industries, this research spending difference for the Semiconductor group has consistent positive coefficient values for both years.

Table 39 Regression of R&D……with Analyst Sales Estimate (Semiconductor companies)(No Revenue)

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log of assets /Sig	Long-term debt/Sales
Current year estimate	.011	.003	4.069	.075/.004	-.020/.438	.07/.010	-.031/.255
Next year estimate	.021	.000	7.930	.116/.000	.028/.274	.088/.001	-.024/.377

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for semiconductor industry group.

Analysis for R&D expenditure more than 5 percent

In their study on long-term abnormal stock returns and operating performance following R&D increases, Eberhart, Maxwell, and Siddque (2004) used companies with research spending greater than 5 percent as their sample data. Their study found consistent evidence of abnormal stock returns experienced by the firm shareholders following the R&D increases. They also observed positive long-term abnormal operating performance following their R&D increases and suggested that the market is slow to recognize the extent of this benefit. One of their sample criteria for selecting data for their study was a 5 percent increase in R&D. My sample data was generated by filtering the data for research spending greater than 5 percent; I then ran correlation and regression tests

against this generated sample data. Tables 40 to 44 show the results of these tests: the sample sizes for R&D spending percentage greater than 5 percent are 4,241 and 4,176, for the current year and next year, respectively, whereas the complete sample without the filter of 5 percent was 6,830 for the current year and 6,690 for the next year. So, using the data filter reduced the sample size by 38 percent for both the current and next year. The correlation results (Table 40) for all companies with research spending greater than 5 percent year over year shows a positive correlation, with .201 and .167 for the current and next year, respectively, and a significance of less than .01 for both years. The correlation results were positive for all companies, with values at .153 and .183 for the current and next year, respectively (Table 13).

Table 40 Correlation R&D with Analyst Sales Estimate for R&D increase > 5%

Years	Sector description	Pearson Correlation	Sig	N
Current year estimate	All IT	.201	.000	4241
Next year estimate	ALL IT	.167	.000	4176

Notes: Correlation of Analyst sales estimate percentage difference (dependent variable) with R & D percentage difference (independent variable) filtered on Analyst EPS estimate percentage > -100 and Analyst EPS estimate percentage < 100% for R&D spending difference year over year > 5%.

The regression results (Table 41) for all companies using the same constructs as in my earlier tests demonstrates that the standard coefficient beta for research spending is .310 and .146 for current year and next year, respectively, with a significance of less than .01. The values of research spending difference are higher than revenue spending

difference. The standard coefficient values for research spending for all IT companies without the R&D spending filter were .221 and .159 for the current and next year, respectively (Table 14).

Table 41 Regression of R&D, Revenue……with Analyst Sales Estimate with R&D increase > 5%

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.130	.000	111.3	.310/.000	.078/.000	.128/.000	.098/.000	-.018/.184
Next year estimate	.057	.000	43.15	.146/.000	.007/.654	.131/.000	.123/.000	.000/.977

Notes : Regression of Independent variables (R&D expenditure percentage difference, Ratio of gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst sales estimate percentage difference (dependent variable) filtered on R&D spending difference year over year > 5%.

The correlation results (Table 42) for analysts' EPS estimate percentage difference compared to R&D percentage difference shows that the correlation is not significant in either year. These results are consistent with the results for all IT companies without the R&D spending filter (Table 23).

Table 42 Correlation R&D with Analyst EPS Estimate for R&D increase > 5%

Years	Sector description	Pearson Correlation	Sig	N
Current year estimate	All IT	.005	.726	4217
Next year estimate	All IT	.016	.281	4304

Notes: Correlation of Analyst EPS estimate percentage difference (dependent variable) with R & D percentage difference (independent variable) filtered on Analyst EPS estimate percentage > -100 and Analyst EPS estimate percentage < 100% for on R&D spending difference year over year > 5%.

Regression results (Table 43) for analysts' EPS estimate percentage difference with the independent variables (research spending, gross margin, assets log, revenue difference, and long-term debt/sales) shows that, for the current year, the correlation in not significant, while for the next year, it is negatively correlated with a value of –.047 and a significance of less than .01. The correlation results for all IT companies (Table 24) for the current year is not significant, while the next year value is –.035. The revenue difference (Table 43) has a positive standard coefficient with a significance of less than .01. The R^2 values are 3 percent and 8 percent and the F values are 26 and 61 for the current and next year, respectively.

Table 43 Regression of R&D, Revenue……with Analyst EPS Estimate for R&D increase > 5%.

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log assets /Sig	Revenue difference	Long-term debt/Sales
Current year estimate	.039	.000	26.70	-.029/.104	-.008/.000	.147/.000	.141/.000	-.028/.115
Next year estimate	.081	.000	61.09	-.047/.007	-.031/.053	.157/.000	.250/.000	-.008/.625

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Revenue difference, Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for on R&D spending difference year over year > 5%.

I performed the regression again by removing the revenue difference construct for the R&D spending difference of greater than 5 percent year over year. The research spending standard coefficient values are not significant (Table 44), the R^2 values for both years are 1 percent, and the F values are 12 and 13 for the current and next year, respectively.

Table 44 Regression of R&D……with Analyst EPS Estimate (No Revenue) filtered for R&D increase > 5%

Years	R2	Sig	F	Research spending /Sig	Gross Margin/Sig	Log assets /Sig	Long-term debt/Sales
Current year estimate	.011	.000	12.21	.008/.600	-.020/.202	.110/.000	-.033/.038
Next year estimate	.013	.000	13.86	.020/.913	-.018/.227	.115/.000	-.018/.240

Notes: Regression of independent variables (R&D percentage difference, gross margin, Log(Assets), Long-term debt/sales) with Analyst EPS estimate percentage difference (dependent variables) filtered on Analyst EPS estimate % > -100% and Analyst EPS estimate < 100% for on R&D spending difference year over year > 5%.

VI CHAPTER 6: DISCUSSION

After reviewing the correlation test results for all the IT companies, I found that R&D expenditure has a positive correlation with analysts' sales estimates. These results are consistent for the current year and the next year, but the next year results show higher correlation than the current year. The correlation results for analysts' EPS estimates and R&D expenditure are different than for the analysts' sales estimate correlation results. The results for all IT companies show that the R&D spending and the analysts' EPS estimates do not have a significant correlation. The next year correlation values are close to significant, and they improved from the current year correlation values.

The regression results for all IT companies using the independent variables (R&D expenditure difference percentage, gross margin, assets log, revenue difference, long-term debt/sales) and the dependent variable (analysts' sales estimate percentage difference) reveal a strong R^2 for both years and a significant positive standard coefficient beta for both years. The revenue and assets have a significant standard coefficient beta for both years, whereas the research spending standard coefficient reduces year over year.

Summary of all Correlation of analyst sales and EPS with R&D

Table 45 Consolidated Correlation of R&D with Analyst Sales and EPS Revision

	Current/Next	Data filtered on	Correlation	Sig	N	Supporting Hypothesis
Sales	Current year	All IT companies	.153	.000	6860	Yes
		>=10 billion	.569	.000	421	Yes
		>1 billion & <10billion	.350	.000	1685	Yes
		=< 1 billion	.128	.000	4502	Yes
		Software and Services	.210	.000	2719	Yes
		Technology Hardware and equipment	.088	.000	2458	Yes
		Semiconductor	.136	.000	1683	Yes
		R&D spending percentage > 5	.201	.000	4241	Yes
	Next year	All IT companies	.183	.000	6690	Yes
		>=10 billion	.479	.000	421	Yes
		>1 billion & <10billion	.361	.000	1674	Yes
		=< 1 billion	.102	.000	3969	Yes
		Software and Services	.205	.000	2657	Yes
		Technology Hardware and equipment	.211	.000	2369	Yes
		Semiconductor and Semiconductor equipment	.120	.000	1664	Yes
		R&D spending percentage > 5	.167	.000	4176	Yes

EPS	Current year	All IT companies	.008	.536	6387	Not Significant
		>=10 billion	.134	.007	404	Yes
		>1 billion & <10billion	.050	.051	1533	Yes
		=< 1 billion	.013	.457	3370	Not Significant
		Software and Services	.014	.486	2555	Not Significant
		Technology Hardware and equipment	.004	.844	2388	Not Significant
		Semiconductor	.078	.003	1475	Yes
		R&D spending percentage > 5	.005	.726	4217	Not Significant
	Next year	All IT companies	.021	.084	6515	Not Significant
		>=10 billion	.223	.000	405	Yes
		>1 billion & <10billion	.133	.000	1558	Yes
		=< 1 billion	.055	.001	3425	Yes
		Software and Services	.036	.072	2568	Not Significant
		Technology Hardware and equipment	.017	.390	2476	Not Significant
		Semiconductor and Semiconductor equipment	.110	.000	1492	Yes
		R&D spending percentage > 5	.016	.281	4304	Not Significant

The same correlation tests that were executed for analyst sales estimates and R&D spending difference were performed for the first 10 years to observe analysts' pattern of

revising analyst sales and EPS estimates. Table 46 shows the results for the first 10 years (1995–2004). The results for next 10 years (2005–2014) are captured in Table 47.

Summary of all Correlation of analyst sales and EPS with R&D for first 10 years

Table 46 Consolidated Correlation of R&D with Analyst Sales and EPS Revision for first 10 years (1995 – 2004)

	Current/Next	Data filtered on	Correlation	Sig	N	Supporting Hypothesis
Sales	Current year	All IT companies	.232	.000	3280	Yes
		>=10 billion	.584	.000	153	Yes
		>1 billion & <10billion	.370	.000	625	Yes
		=< 1 billion	.208	.000	2050	Yes
		Software and Services	.361	.000	1369	Yes
		Technology Hardware and equipment	.093	.000	1238	Yes
		Semiconductor	.144	.000	673	Yes
		R&D spending percentage > 5	.223	.000	2063	Yes
	Next year	All IT companies	.221	.000	3145	Yes
		>=10 billion	.473	.000	153	Yes
		>1 billion & <10billion	.385	.000	614	Yes
		=< 1 billion	.138	.000	1884	Yes
		Software and Services	.251	.000	1319	Yes
		Technology Hardware and equipment	.230	.000	1167	Yes
		Semiconductor and Semiconductor equipment	.162	.000	659	Yes
		R&D spending percentage > 5	.200	.000	2010	Yes

Summary of all Correlation of analyst sales and EPS with R&D for last 10 years

Table 47 Consolidated Correlation of R&D with Analyst Sales and EPS Revision for first 10 years (2005 – 2014)

	Current/Next	Data filtered on	Correlation	Sig	N	Supporting Hypothesis
Sales	Current year	All IT companies	.046	.006	3580	Yes
		>=10 billion	.247	.000	268	Yes
		>1 billion & <10billion	.278	.000	1060	Yes
		=< 1 billion	.02	.343	2119	Not Sig
		Software and Services	.009	.744	1350	Yes
		Technology Hardware and equipment	.132	.000	1220	Yes
		Semiconductor	.130	.000	1010	Yes
		R&D spending percentage > 5	.070	.000	2192	Yes
	Next year	All IT companies	.108	.000	3545	Yes
		>=10 billion	.258	.000	268	Yes
		>1 billion & <10billion	.320	.000	1060	Yes
		=< 1 billion	.062	.005	2085	Yes
		Software and Services	.093	.001	1338	Yes
		Technology Hardware and equipment	.201	.000	1202	Yes
		Semiconductor and Semiconductor equipment	.065	.039	1005	Yes

R&D spending percentage > 5	.075	.000	2179	Yes

VI.1 Correlation analysis

A review of all of the companies in Table 45 shows a strong correlation that supports Hypothesis 1.

Hypothesis 1: A change in R&D expenditure impacts analysts' sales estimate forecasts for the current year.

The market capitalization segmentation analysis shows that correlation strength varies depending on company size: large companies have a strong positive correlation, midsized companies have a positive correlation, and small companies have a relatively weak correlation. Srinivasan's (2007) study shows the contingent effect of a firm's advertising and R&D expenditures on the dispersion in analysts' forecast of earnings, suggesting that analysts pay attention to firms' marketing activities. Srinivasan further adds that firms with a record of past performance, have decreased dispersion in analyst forecasts. Typically, large and midsized companies have been in business longer and have past experience that gives analysts more confidence when they update their estimates. The greater the firm's R&D expenditure, the lower the support for dispersion in analysts' forecast hypotheses (Srinivasan 2007). Over the past two decades, smaller firms have begun allocating more money to R&D (see Table 48). Hirschey et al. (2012) discuss how the R&D share is being distributed among large, medium, and small companies. For example, companies that Hirschey et al. ranked above 1,000 spent more

than $1 billion on R&D in 2010. (Their data does not include financial or utility companies.)

Table 48 Distribution of R&D Spending

(Hirschey et al)

Panel A: R&D

Ranking	R&D Share		Cumulative R&D Share		Real R&D (2010 $millions)	
	1976	2010	1976	2010	1976	2010
top 100	79.1%	75.7%	79.1%	75.7%	$39,611.5	$170,647.1
101-200	10.7%	9.6%	89.8%	85.2%	5,343.7	21,638.8
201-300	4.1%	4.5%	93.9%	89.7%	2,055.1	10,110.8
301-400	2.2%	2.9%	96.1%	92.6%	1,092.5	6,500.0
401-500	1.3%	2.1%	97.4%	94.7%	675.5	4,730.8
501-600	0.9%	1.5%	98.4%	96.2%	462.5	3,453.4
601-700	0.6%	1.1%	99.0%	97.4%	308.0	2,534.5
701-800	0.4%	0.8%	99.4%	98.2%	215.4	1,893.9
801-900	0.3%	0.6%	99.7%	98.8%	139.0	1,390.0
901-1000	0.2%	0.4%	99.9%	99.3%	89.5	999.9
1001-1100	0.1%	0.3%	100.0%	99.6%	46.4	690.6
1101-1200		0.2%		99.8%	15.7	448.6
1201-1300		0.1%		99.9%		276.4
1301-1400		0.1%		100.0%		173.2
1401-1500		0.0%		100.0%		75.5
1501-1600		0.0%		100.0%		7.5
Total for all firms	100.0%	100.0%	100.0%	100.0%	$50,054.9	$225,571.0

From a comparative review of industry segmentation, the Software and Services group has a stronger positive correlation than the Technology Hardware or Semiconductor groups, but all three industry groups are positively correlated. In a 2014 *Market Realist* article, Hirschey et al. discuss the software company cost structure of IT companies, noting that the majority of their operating expenditures consist of R&D costs and marketing spending. With the emergence and adoption of cloud computing and open source software, companies are finding it very difficult to maintain the high margins once associated with the industry (*Market Realist*, 2014). They note that software companies spend more on R&D investment to differentiate those products that are hard to replicate or that are protected by intellectual property rights or patents. Patents serve as armor for

software companies. Small companies and start-ups find patents hard to penetrate; establishing a strong customer base makes switching costs very high and adds to the challenges of start-ups.

As per Bloomberg's data, between 2013 and 2014, the Internet companies Google and Amazon increased their R&D spending by 17 and 43 percent, respectively; hardware companies IBM and Cisco increased their R&D spending by –1.2 and 8.3 percent, respectively; and the Semiconductor company Intel increased its R&D spending by 4.6 percent. The growth of cloud technology, which has impacted hardware companies' revenues for the past decade, has not given analysts the confidence to update that sector's forecast. As other researchers have noted, past performance of companies decreases dispersion in analyst forecasts (Srinivasan, 2007). In my analysis of companies that have increased their R&D spending by 5 percent, I found a strong positive correlation between R&D spending and analyst sales estimate revisions for the current year.

Hypothesis 2: A change in R&D expenditure impacts analysts' sales estimate forecasts for the next year.

I ran correlation and regression tests for only one year following the current year; testing beyond that reduces the analyst forecast quality. The O'Brien study (1988) compares consensus analyst forecasts with time-series forecasts from one- to four-quarters ahead. The analyst forecasts outperform the time-series model for one- and two-quarter-ahead forecasts, are approximately the same for three-quarter ahead forecasts, and perform worse for four-quarter ahead forecasts. Thus, the advantage analysts gain from firm-specific information seems to deteriorate as the time horizon for forecasting is

extended. In valuation, the focus is more on long-term growth rates in earnings than on next quarter's earnings. There is little evidence to suggest that analysts provide superior earnings forecasts when those forecasts span three or five years. An early study by Malkiel & Cragg (1980) compared long-term forecasts by five investment management firms in 1962 and 1963 with actual growth over the following three years; they concluded that analysts were poor long-term forecasters.

In my study, the correlation for next year is positive in all categories: for all IT companies, it was slightly higher and, for hardware companies, the next year correlation was higher than the current year. Another noticeable result was that, in the smaller companies, the next year correlation is not as strong as the current year. The fact that the analyst forecasts are not accurate over the longer term might be due to other unknown factors, such as interest rate changes and industry-specific fluctuations. These characteristics that are not firm-specific impact long-term analyst forecasts, which reduces the correlation for smaller companies as they often lack the past performance information that analysts use to update their next year estimates. Fairfield, Ramnath, and Yohn (2009) describe how industry-specific models generate more accurate forecasts of sales growth in firms because "firms' sales growth depends on product demand, which are determined at the industry level."

Hypothesis 3: A change in R&D expenditure impacts analysts' EPS estimate forecasts for the current year.

When reviewing the correlation between analysts' current year EPS estimates and R&D expenditures for all companies, the results are not significant. The companies with

more than $10 billion market value show positive correlation, as do midsized companies (between $1 billion and $10 million in market value), whereas the correlation is not significant with smaller companies. This might be due to various other expenses that impact the EPS, despite a positive correlation with the sales. For example, Company A might increase its R&D budget and see sales increase in the current year or next year, but expenses such as additional marketing expenses or hiring more customer service personal to support the new products might impact the EPS and hence analysts might not change the EPS based on R&D expenditure revisions.

Past performance of the companies can also influence analyst updates of the EPS. Large and midsized companies with more of an R&D history might inspire analysts to modify the EPS estimates. Semiconductor companies show a positive correlation here, whereas Software and Services and Technology Hardware and Equipment companies do not show significant results.

Hypothesis 4: A change in R&D expenditure impacts analysts' EPS estimate forecasts for the following year.

The next year results for analysts' EPS estimate forecasts are much better than the current year results. This is because other costs associated with products are reduced as the years go by, so analysts increase the earnings. When comparing for companies with market cap greater than $10 billion, the correlation value is .223—much higher than the current year value of .134. Midsized companies show a next year correlation value of .133, compared to a current year value of .050. For small capitalization companies, the next year results show a positive correlation compared to the current year, where the

results were not significant. In terms of industry groups, Technology Hardware correlation for the next year is not significant; the values are similar to the current year. As with the current year, Software and Services results are not significant for the next year, though the significance value is lower at .07. For the Semiconductor industry, the correlation results for the next year are higher than the current year, but both are positively correlated. The correlation results for R&D spending greater than 5 percent over the previous year is not significant.

Table 49 Correlation Summary of All Tests, Year Wise View

	Sales		EPS	
	Current year	Next year	Current year	Next year
All IT companies	.153	.183	Not Sig	Not Sig
>=10 billion	.569	.469	.134	.223
>1 billion & <10billion	.350	.361	.050	.133
=< 1 billion	.128	.102	Not Sig	.055
Software and Services	.210	.205	Not Sig	Not Sig
Technology Hardware and	.088	.211	Not Sig	Not Sig
Semiconductor	.136	.120	.078	.110
R&D spending percentage > 5	.201	.167	Not Sig	Not Sig

Notes : Correlation summary of R&D difference to Analyst sales and EPS estimate changes.

Table 49 consolidates the summary of all correlation results. As a review of this table shows, Hypothesis 1 and Hypothesis 2 are strongly supported. Hypotheses 3 and 4 are not significant for all tests, but Hypothesis 4 has better results than Hypothesis 3. Givoly, Hayn, and D'Souza's (1999) study shows that there is a stronger correlation between firm sales and industry sales than between firm profits and industry. Sales

increases are not impacted by other expenses that normally impact the EPS, such as interest expenses and tax law changes. So, R&D spending has direct association with the sales estimate, whereas for the EPS is impacted by many other factors.

It is also clear that the current year sales correlation results are stronger than the next year's results, but for EPS, the next year correlation results are stronger than the current year. This phenomenon is due to the fact that R&D spending by IT might show revenue benefit the same year as the IT industry is moving at a rapid pace. The next year EPS results are better because the current year includes additional marketing and training costs to launch the product; these costs reduce in the years that follow.

When I analyzed the results for first 10 years and compared them with next 10 years, I noticed a change in analyst's behavior. The decade wise results were gathered by running correlation tests for the analyst sales estimate difference with R&D spending changes. Table 50 shows the results from both tests. These decade wise results are compared against the test results from 20 years.

Table 50 Correlation tests for analyst sales estimate with R&D decade wise compared with 20 years data

	Current/Next	Data filtered on	1995-2004	2005-2014	1995 - 2014
Sales	Current year	All IT companies	.232	.046	.153
		>=10 billion	.584	.247	.569
		>1 billion & <10billion	.370	.278	.350
		=< 1 billion	.208	Not Sig	.128
		Software and Services	.361	.009	.210
		Technology Hardware and equipment	.093	.132	.088
		Semiconductor	.144	.130	.136
		R&D spending percentage > 5	.223	.070	.201
	Next year	All IT companies	.221	.108	.183
		>=10 billion	.473	.258	.479
		>1 billion & <10billion	.385	.320	.361
		=< 1 billion	.138	.062	.102
		Software and Services	.251	.093	.205
		Technology Hardware and equipment	.230	.201	.211
		Semiconductor and Semiconductor equipment	.162	.065	.120
		R&D spending percentage > 5	.200	.075	.167

The results for the decade from 1995–2004 illustrate that the next year correlation results are lower than the current year results; however, for midsized companies, the Technology Hardware and Semiconductor industries' next year results are higher than the current year. The results for 1995–2004 follow the same pattern as the 20-year correlation results, except for IT and semiconductor companies.

My analysis also showed that the pattern for 2005–2014 was different than that for 1995–2004. The correlation results for 2005–2014 are positive, but they are much lower than the 1995–2004 results. Also the results indicate that the next year results for 2005–2014 are higher than current year results. Based on these results, there is strong evidence that the R&D spending differences in the past decade (2005–2014) are associated more with the next year analyst sales estimate revisions than those of the current year.

VI.2 Regression Analysis

I performed regression analysis using the five independent variables (R&D expenditure difference percentage, gross margin, assets log, revenue difference, and long-term debt/sales) and the analysts' sales estimate percentage difference as the dependent variable. For sales and EPS regression tests, R&D, revenue, and assets log had significant positive standard coefficient, while gross margin and long-term debt/sales did not.

Hypothesis 1: A change in R&D expenditure impacts analysts' sales estimate forecasts for the current year.

I analyzed regression results to see if Hypothesis 1 is supported by R&D changes. For all IT companies, R^2 is .07 and the standard coefficient beta is positive. Segment analysis

shows that, for market capitalization greater than $10 billion, the R^2 is .65 and R&D is not significant, but the revenue coefficient is high at .839. For midsized companies, R^2 is .50 and, similar to large companies, the revenue coefficient is high. Based on this information, I conclude that the revenues are influencing the regression. For large companies, the revenue changes are not volatile and R&D spending change influences will be low. For small companies, the R&D standard coefficient is positive at .217, whereas the revenue is not significant. Also, revenue changes are volatile for small companies, and quite hard to predict, hence the R&D has a greater influence in analysts' sales estimate changes.

Studying industry group segmentation shows that Software and Services and Technology Hardware and Equipment have a positive standard coefficient for R&D expenditure changes. Semiconductor revenue, however, shows a higher coefficient in the regression. As the Bloomberg report showed, Software and Services companies like Google spend more on R&D, and hence analysts are influenced to increase their sales estimates over their revenue estimates. The same report showed that Cisco, a Technology Hardware Company, increased its R&D by a high single digit, whereas the Semiconductor company Intel increased it by only 4 percent. Analysts reviewing the percentage increase of R&D spending are influenced by the industry practice of R&D spending, and will use the latter to update their sales estimate.

For companies with abnormal R&D increases, the R&D year-over-year standard coefficient is .310 compared to .098 for revenue difference. This result shows that, the higher the R&D increase, the more likely analysts are to change their sales forecasts. Based on my analysis of these regression, I conclude that Hypothesis 1 is supported by

the regression test results, even though some results showed that revenue has a considerable influence.

Summary of all regression of Analyst sales and EPS estimate with R&D

Table 51 Consolidated Regression of R&D with Analyst Sales and EPS Revision

	Current /Next	Data filtered on	R^2	F	R&D	Revenue	Others which are significant
Sales	Current year	All IT companies	.075	98	.221	.092	Asset
		>=10 billion	.65	150	Not Sig	.839	
		>1 billion & <10billion	.50	299	Not Sig	.722	
		=< 1 billion	.05	42	.217	Not Sig	Asset
		Software and Services	.08	42	.235	.106	Asset
		Technology Hardware and equipment	.07	35	.195	Not sig	Asset, Gross Margin
		Semiconductor	.51	112	Not Sig	.494	Asset
		R&D spending percentage > 5	.13	111	.310	.098	Asset
	Next year	All IT companies	.069	87	.159	.142	Asset
		>=10 billion	.38	48	Not sig	.636	
		>1 billion & <10billion	.65	222	Not sig	.622	

		=< 1 billion	.02	17	.103	Not Sig	Asset
		Software and Services	.12	60	.168	.229	Asset
		Technology Hardware and equipment	.06	27	.195	Not Sig	Asset, Gross Margin
		Semiconductor and Semiconductor equipment	.16	62	Not Sig	.390	Asset
		R&D spending percentage > 5	.06	43	.146	.123	Asset
EPS	Current year	All IT companies	.02	24	Not Sig	.124	Asset
		>=10 billion	.12	10	Not Sig	.386	
		>1 billion & <10billion	.07	20	-.132	.284	Asset (-), Gross Margin
		=< 1 billion	.01	8	Not Sig	.101	
		Software and Services	.02	8	Not Sig	.115	Asset
		Technology Hardware and equipment	.02	11	-.067	.150	Asset
		Semiconductor	.09	25	Not Sig	.306	
		R&D spending percentage > 5	.04	26	Not Sig	.141	Asset

Next year	All IT companies	.07	83	-.035	.246	Asset
	>=10 billion	.09	8	Not Sig	.304	Asset
	>1 billion & <10billion	.15	50	-.138	.449	Gross Margin
	=< 1 billion	.04	26	Not Sig	.209	
	Software and Services	.06	29	Not Sig	.214	Asset
	Technology Hardware and equipment	.08	36	Not Sig	.260	Asset
	Semiconductor and Semiconductor equipment	.09	26	Not Sig	.284	Asset
	R&D spending percentage > 5	.08	61	Not Sig	.250	Asset

Hypothesis 2: A change in R&D expenditure impacts analysts' sales estimate forecasts for the next year.

Next year regression results (Table 51) are similar to current year regression results. The tests that had a positive standard coefficient for the current year also had a positive standard coefficient for the next year. The next year's standard coefficient is slightly less than the current year results. As I noted earlier, the O'Brien study (1988) confirms that analyst forecasts that are more than four quarters ahead are worse than those derived using the time-series model. Other macro and industry factors impact analysts' sales estimates for the next year. For example, Skyworks Solutions Company, a supplier to

Apple, might increase its R&D spending, but if Apple revenue is expected to reduce due to China's slowing growth, analysts might not increase their sales estimate forecasts for Skyworks. The next year results show that, for large companies, midsized companies, and Technology Hardware companies, the revenue independent variable influences the regression more than R&D expenditures. Thus, when comparing the next year values, the revenue coefficient is slightly lower than the current year.

R&D spending increases of more than 5 percent have a positive standard coefficient for all companies and a greater influence on regression than on revenue. Out of eight regression tests, five show that R&D has bigger influence on the regression than the revenue, with a positive coefficient. These results support Hypothesis 2—that R&D expenditure change impacts analysts' next year sales estimate forecasts.

Hypothesis 3: A change in R&D expenditure impacts analysts' EPS estimate forecasts for the current year.

Analyst EPS regression results for all IT companies—using analysts' EPS estimate forecasts as the dependent variable—show that R&D spending differences have little influence on the regression. However, regression test results show that revenue spending's standard coefficient is positive and has as strong influence on regression. Further, analysts take other costs into consideration, and hence will be unlikely to modify their EPS estimate. For example, strong competition requires more spending on marketing the product, which impacts the bottom line and might prevent analysts from modifying their EPS estimates. Also, companies typically hire customer service reps to

support new products, and this cost also impacts the bottom line and might be another reason why analysts are hesitant to update EPS estimates.

I performed regression without the revenue as a dependent variable, while keeping the other four independent variables and the analysts' EPS estimate revisions as the dependent variable. The results (Table 52) show that, for large and midsized market capitalization companies, the R&D change is significant, with a positive standard coefficient. In the Semiconductor group, companies have a positive standard coefficient. For all these tests, the R^2 and F values are quite low. Thus, regarding Hypothesis 3, the regression test shows that revenue is a strong influencer on analysts' EPS estimates, but when revenue is removed from the regression, three out of eight tests demonstrate a positive standard coefficient. Thus, hypothesis 3 is partially supported when revenue is not part of the regression.

Summary of all regression of Analyst EPS estimate with R&D, without Revenue

Table 52 Consolidated Regression of R&D with Analyst Sales and EPS Revision (No Revenue)

	Current /Next	Data filtered on	R^2	F	R&D
EPS	Current year	All IT companies	.005	7.2	Not Sig
		>=10 billion	.02	2.1	.114
		>1 billion & <10billion	.02	8.2	.026
		=< 1 billion	.01	7.8	Not Sig
		Software and Services	.00	2.9	Not Sig
		Technology Hardware and equipment	.00	2.9	Not Sig
		Semiconductor	.01	4.0	.07
		R&D spending percentage > 5	.01	12.21	Not Sig
	Next year	All IT companies	.01	15	Not Sig
		>=10 billion	.05	.00	.206
		>1 billion & <10billion	.04	15	.106
		=< 1 billion	.00	3.7	.054
		Software and Services	.01	11	.044
		Technology Hardware and equipment	.01	8.5	Not Sig
		Semiconductor and Semiconductor equipment	.02	.00	7.9
		R&D spending percentage > 5	.01	13.8	Not Sig

Hypothesis 4: A change in R&D expenditure impacts analysts' EPS estimate forecasts for the following year.

EPS next year regression test results (Table 51) are similar to the current year regression results: revenue difference has more influence in the regression for all eight tests and R&D is not significant; where it is significant, the values are negative standard coefficients. The same reasons as for current year analysts' using revenue over R&D apply for the next year test results. I reran regression without revenue, keeping other independent variables, to understand the behavior of R&D change on the regression. Results show that, in three out of eight tests, the R&D differences had a positive standard coefficient for the next year. Five out of the eight tests had a positive standard coefficient, while the next year results had a higher coefficient than the previous year's values.

Large capitalization company values were .206, while midsized capitalization company values were .106. The current year values were .114 for large companies and .026 for midsized companies. I also found a significant increase in the coefficient in the next year results. The values of small companies and software companies were not significant in the current year, but have a positive standard coefficient in the next year. As stated in the correlation analysis, analysts modify EPS estimates based on R&D differences in the**:** previous year. Analyst are recognizing that R&D spending in large companies is based on past R&D investment experiences and their impact on the company's financial results.

Regression summary of R&D difference to Analyst sales and EPS estimate changes.

Table 53 Regression Summary of All Tests, Year Wise View

	Sales		EPS		Without revenue difference	
	Current year	Next year	Current year	Next year	Current year	Next year
All IT companies	.221	.159	Not Sig	-.035	Not Sig	Not Sig
>=10 billion	Not Sig	Not sig	Not Sig	Not Sig	.114	.206
>1 billion & <10billion	Not Sig	Not sig	-.132	-.138	.026	.106
=< 1 billion	.217	.103	Not Sig	Not Sig	Not Sig	.054
Software and Services	.235	.168	Not Sig	Not Sig	Not Sig	.044
Technology Hardware and	.195	.195	-.067	Not Sig	Not Sig	Not Sig
Semiconductor	Not Sig	Not Sig	Not Sig	Not Sig	.07	7.9
R&D spending percentage > 5	.310	.146	Not Sig	Not Sig	Not Sig	Not Sig

Table 53 shows all the results, summarizing all of the regression tests in a single snapshot. The regression results are similar to correlation in terms of sales estimate revisions: five out of the seven tests are supported in the current and next year results. The pattern of R&D impact on analysts' sales estimates reduces in the next year, which matches the pattern observed in analysts' sales estimate revisions and R&D difference correlation results. Based on the earlier observations, I conclude that hypotheses 1 and 2 are supported. Summarizing analysts' EPS estimates shows no significance for R&D difference in the regression, and revenue difference is the primary influencer on the estimates. When I remove revenue difference from the regression, large, midsized, and

Semiconductor companies' R&D change results are significant; the past R&D performance of these companies influence analysts' to update their EPS estimates. A January 2009 survey conducted by the US National Science Foundation and the US Census Bureau found that companies with fewer than 500 employees accounted for 11 percent of worldwide sales for all US companies, but 19 percent of research spending. Companies with more than 25,000 employees accounted for 42 percent of global sales, but just 36 percent of research outlays. These very small companies (those with 5 to 24 employees) spent $3 billion—that is, at least 50 percent more than all other small firms (those with fewer than 500 employees)—in payments to others to do research. The tinest of the companies also had the most research ($5 billion worth) paid for by others (Courtney Rubin, Inc., 2009).

Even though the large companies with more than 25,000 employees are smaller in number, they account for 36 percent of the total research spending. Companies gradually increase their research spending; for large companies, this creates a trail of past performance that lets analysts revise their estimates based on R&D spending over time. The next year results for EPS estimate revision impact shows five positive coefficients, and their values are higher than the current year, which follows the pattern of EPS correlation results. Regression patterns match correlation patterns when the results are compared year over year. The current year results in sales estimate regression are stronger than the next year results; however, for EPS estimates, the regression without revenue difference shows stronger next year results than current year results. R&D revisions that impact analysts' sales revisions for IT companies are seen in the same year, while analysts' EPS estimate changes due to R&D revisions are seen in the next year due

to the additional costs involved in launching a new product. Table 54 shows the results of the Hirschey et al. study that compared research spending changes from 1976 to 2010. Although smaller companies are spending more, the number of firms that spent less than $25 million increased by 53 percent, while large ($250 million or more in spending) and midsized companies (between $25 and $250 million) showed 490 percent and 134 percent growth, respectively.

Table 54 Number of R&D Firms

(Hirschey et al, 2012)

Panel A: R&D

Real spending (2010 dollars)	Number of firms 1976	Number of firms 2010	Change (1976-2010)	Percentage change (1976-2010)	Real R&D 1976	Real R&D 2010	Change (1976-2010)	Percentage change (1976-2010)
$2 billion or more	2	19	17	850.0%	$7,422.7	$102,888.8	$95,466.1	1286.1%
$1 to $2 billion	5	24	19	380.0%	6,660.2	35,179.4	28,519.2	428.2%
$500 million to $1 bill	11	31	20	181.8%	7,825.9	21,292.3	13,466.4	172.1%
$250 to $500 million	23	54	31	134.8%	8,458.2	20,013.7	11,555.5	136.6%
$100 to $250 million	54	120	66	122.2%	8,766.3	18,464.5	9,698.2	110.6%
$50 to $100 million	54	184	130	240.7%	3,969.9	12,714.7	8,744.9	220.3%
$25 to $50 million	70	221	151	215.7%	2,357.5	7,970.0	5,612.5	238.1%
$10 to $25 million	143	297	154	107.7%	2,298.9	4,925.5	2,626.6	114.3%
less than $10 million	841	594	-247	-29.4%	2,295.3	2,122.1	-173.3	-7.5%
Total	1,203	1,544	341	28.3%	$50,054.9	$225,571.0	$175,516.1	350.6%
$250 million and above	41	128	87	212.2%	30,367.0	179,374.2	149,007.2	490.7%
Less than $250 million	1,162	1,416	254	21.9%	19,687.9	46,196.8	26,508.9	134.6%
Less than $25 million	984	891	-93	-9.5%	4,594.2	7,047.6	2,453.3	53.4%

Table 55 shows the results of Hirschey et al.'s study in terms of R&D spending to total earnings as reported by the top 100 R&D spenders, the next 100 largest, and so on. (Again, these figures do not include financial or utilities companies.)

Table 55 Earnings of R&D Firms

(Hirschey et al, 2012)

Panel A: Earnings of R&D Firms

Ranking	Share of total earnings, R&D spending industrials 1976	Share of total earnings, R&D spending industrials 2010	Cumulative share of total earnings, R&D spending industrials 1976	Cumulative share of total earnings, R&D spending industrials 2010	Real earnings of R&D spending industrials (2010 $millions) 1976	Real earnings of R&D spending industrials (2010 $millions) 2010
top 100	70.1%	77.0%	70.1%	77.0%	$108,991.8	$346,495.6
101-200	14.9%	10.3%	85.1%	87.3%	23,201.6	46,464.3
201-300	5.2%	3.6%	90.3%	90.9%	8,140.4	16,083.6
301-400	2.8%	2.8%	93.1%	93.7%	4,391.9	12,602.8
401-500	2.0%	1.0%	95.1%	94.7%	3,066.4	4,672.4
501-600	1.2%	1.5%	96.3%	96.2%	1,863.4	6,684.5
601-700	1.1%	0.8%	97.4%	97.0%	1,678.3	3,484.0
701-800	0.9%	0.8%	98.3%	97.8%	1,413.8	3,672.7
801-900	0.8%	0.6%	99.1%	98.4%	1,260.3	2,925.3
901-1000	0.4%	0.2%	99.5%	98.7%	639.0	1,005.5
1001-1100	0.2%	0.1%	99.8%	98.8%	365.9	564.5
1101-1200	0.2%	0.8%	100.0%	99.6%	358.7	3,651.6
1201-1300	0.0%	0.2%	100.0%	99.8%	10.9	898.0
1301-1400		0.1%		99.9%		571.5
1401-1500		0.0%		99.9%		123.7
1501-1600		0.1%		100.0%		226.9
Total for all firms	**100%**	**100%**	**100%**	**100%**	**$155,382.5**	**$450,127.0**

VI.3 Summary of Hypothesis Results

Table 56 Summary of Hypothesis Results

	Correlation	Regression	Regression without Revenue difference
Hypothesis 1	Supported	Supported	
Hypothesis 2	Supported	Supported	
Hypothesis 3	Supported	Not Significant	Partially Supported
Hypothesis 4	Supported	Not Significant	Supported

Table 56 summarizes the hypothesis findings in the correlation and regression tests. Hypotheses 1 and 2 are supported by both correlation and regression. Hypotheses 3 and 4 are supported by correlation testing. During regression testing, when the revenue difference variable is removed, Hypothesis 4 is supported and Hypothesis 3 is partially supported.

VI.4 Contribution to Practice

This study finds a statistically significant relationship between the changes in R&D spending and analysts' sales estimate forecasts. Although there is strong belief in the industry that R&D spending impacts company revenues, analysts recognize the benefits of R&D differently based on a company's size and IT sector. Further, analysts update their sales and EPS estimates in different ways for the current and the next year. This research breaks down the relationship between the R&D spending and analysts' sales estimate revisions and EPS estimate revisions using 20 years' worth of IT sector data. Practitioners, company leaders and chairmen, and chief executive officers (CEOs) can review this report when making decisions about R&D spending. Previous studies have proven a strong correlation between analyst revisions of company revenue and earnings to stock price movement. Top managers at all firms are interested in increasing their stock price.. This research paper will help the CEOs and chief financial officers (CFOs) of IT companies make decisions about how to allocate R&D expenditures for their company in a way that benefits them in both the short and long term.

As these research results show, a strong correlation exists between R&D spending and analysts' sales estimates, and how the EPS revisions increase next year over current year based on R&D spending. The economic significance of the estimates is large. I find that

analysts typically adjust their EPS estimates in a range of about 5-30 percent of the percentage change in R&D expenditures. So if R&D expenditures were to change by 50%, for example, analyst EPS revisions would change by about 2.5 to 15 percent. This understanding is especially important for small companies, since they have fewer market participants who follow their stock.

Companies that are planning to diversify from one industry to another can also benefit from this research, including hardware companies that are planning to move into the software business. IBM, which is a primarily a hardware company, has moved into the software industry over the past two decades. Companies wanting to take the path of IBM or vice versa can review this report to get an overview of their R&D allocation to different segments.

Finally, companies that are growing in market capitalization can benefit from this study, which can help them understand how R&D spending impacts the analysts' estimates in sales and earnings.

VI.5 Contribution to Theory

My study fills a gap in the literature by examining how analysts use R&D expenditures to adjust their sales and EPS estimates. In theory, increased R&D should lead to increased sales, which should translate to increased earnings. Academic research has traditionally focused on R&D spending and its impact on earnings. For example, Chan et al.'s study (2001) focused on R&D spending's financial impact on high-tech companies. My paper is the first to shed light on how analysts perceive the linkage between R&D, sales, and earnings. In so doing, I provide the bridge to other strands of the R&D and analyst literature. One of these strands is the relationship between C-level

executives' compensation and R&D spending. Another is a line of literature that links analyst estimates and their impact on stock price.

While Keung (2010) has discussed the importance of analyst forecast sales and earnings forecast revisions, little research has been done on R&D and analysts' estimates, and none has studied R&D spending and its impact on analysts' sales and EPS estimates. This research helps to fill that academic gap by examining companies' R&D expenditures in relation to these key analyst estimates.

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