More than Numbers: R&D-related Disclosure and Firm Performance

by

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DEDICATION

I dedicate this dissertation to my wife, Andrea, and children Joseph, Elizabeth, and Madeline for their enduring support and sacrifice to help me follow my academic pursuits and the career that continually captivates my interest.

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CHAPTER 1

INTRODUCTION

In this dissertation I examine how reported earnings performance influences firms' decisions to provide disclosure about their research and development (R&D) activities in their 10-K reports. Understanding firms' disclosure decisions is a fundamental issue in the accounting literature.[1] In particular, the role of firm performance in disclosure decisions has received considerable attention from academic researchers as well as from external stakeholders and regulators.[2] A large body of this literature suggests that the likelihood that firms' voluntarily disclose a specific set of information is increasing in the performance news it contains (Verrecchia 1983; Dye 1985). However, mandatory financial disclosures such as earnings also report performance news to investors and it is not well understood how the news (i.e., good vs. bad news) communicated in these disclosures influences firms' decisions to voluntarily provide additional disclosure information such as R&D disclosure or to provide different types of disclosures such as quantitative or qualitative disclosures.[3]

[1] In fact, Verrecchia (1990) states that understanding managerial incentives to disclose information is "the quintessential accounting problem."

[2] Examples of analytical work include Grossman and Hart (1980), Grossman (1981), Milgrom (1981), Verrecchia (1983), Dye (1985), and Jung and Kwon (1988).

[3] For example, Einhorn (2005) predicts that firms' are equally likely to provide voluntary disclosures, regardless of whether mandatory disclosures are favorable or unfavorable, while Bagnoli and Watts (2007) predict that the likelihood of voluntary disclosure depends on the absolute magnitude of the news in the mandatory reports. Under certain assumptions it can be shown that the likelihood of disclosure could vary negatively or positively with the news in mandatory reports (Duvall 1967; Baiman and Demski 1980; Hughes and Pae 2004). In addition, none of these models consider the difference between quantitative and qualitative disclosure types.

Prior empirical research typically focuses on how performance influences the disclosure of quantitative financial information that directly summarizes financial performance (e.g., earnings, earnings guidance, or accounting segment data).[4] However, a comparatively large amount of disclosure information such as R&D disclosure is more qualitative in nature (i.e., presented in narrative form) and is not directly incorporated in the financial statements. Prior research focuses less on this type of disclosure, perhaps because it is difficult to measure and quantify. Nonetheless, qualitative disclosure is important because it helps market participants bridge the gap between the financial statements and the economic reality of firms' operations (Glassman 2003).

Recent empirical studies find that the textual characteristics (e.g., readability and tone) of qualitative disclosures have information content beyond that contained in quantitative accounting disclosures and are associated with important economic consequences such as equity mispricing and the characteristics of firms' information environments (Davis et al. 2008; Li 2008, 2010; Feldman et al. 2009; Brown and Tucker 2010; Lehavy, Li, and Merkley 2010). But less is known about the determinants of firms' decisions to provide specific types of qualitative disclosure content and, importantly, whether the role of reported performance on these disclosures differs from more quantitative disclosures. To address these limitations, I examine the relation between reported earnings performance and qualitative disclosure in the context of R&D-related disclosures and contrast this relation with that of earnings guidance decisions.

The R&D setting, in particular, offers several features that highlight the value of qualitative supplementary disclosure to market participants. First, prior research suggests

[4] For examples, see Patell (1976), Penman (1980), Ajinkya and Gift (1984), Lev and Penman (1990), Skinner (1994), Kasznik and Lev (1995), Harris (1998), Healy and Palepu (2001), Botoson and Stanford (2005), and Berger and Hann (2007).

that financial statements do not communicate effectively the value of R&D investments, especially when financial performance is low (Hayn 1995; Lev 1999; Lev and Zarowin 1999; Franzen et al. 2007). In this case, information about firms' R&D activities can play an important role by helping investors assess the nature and causes of lower financial performance and improve their understanding of the fundamentals of firms' operations (Joos and Plesko 2005). Second, R&D investments are associated with significantly high levels of risk and information asymmetry with respect to their potential outcomes (Aboody and Lev 2000). Disclosure that helps investors assess these outcomes is especially important because R&D has a significant impact on firm value and economic growth.[5] The combination of investors' need for R&D-related information and the limitations of financial statements to convey it provides managers an important disclosure opportunity. They can provide supplemental R&D disclosure to improve investors' understanding of firms' fundamental business activities as well as their assessment of firms' future prospects.

To identify R&D-related disclosures, I construct a measure based on the number of R&D-related sentences provided in 10-K filings. I categorize a sentence as R&D-related if it contains specific R&D-related keywords or phrases (see Appendix A). To identify the content of R&D-related disclosures, I classify R&D-related sentences into subjects, such as progress, competition, and facilities, based on the words provided in each sentence (see Appendix B for examples).[6] Using a sample of 20,990 10-K filings of

[5] See Griliches (1981, 1998), Jaffe (1986), Romer (1986, 1990), Lucas (1988), Hall (1993), Aghion and Tirole (1994), Sougiannis (1994), Lev and Sougiannis (1996), Chan et al. (2001), and Lev (2001).

[6] I use 10-K disclosures to measure firms' qualitative R&D-related disclosures because they are provided concurrently with the audited financial statements. However, the main inferences of this study continue to hold using the number of R&D-related press releases for a reduced sample of R&D intensive firms (see Appendix C for results). In addition, in Section 4.5 I show that my measure differs from total 10-K length with respect to its association with absolute stock returns and relative bid-ask spreads.

firms that invest in R&D from 1996-2007, I find that firms disclose, on average, about 31 R&D-related sentences per 10-K.

My first hypothesis considers how changes in reported earnings performance explain firms' R&D disclosure behavior. On the one hand, as earnings performance decreases, reported earnings becomes less predictive of future performance, i.e., the earnings signal becomes noisier (Hayn 1995; Joos and Plesko 2005). In addition, the information asymmetry between insiders and external investors increases (Wittenberg-Moerman 2008; Brown et al. 2009; Ng et al. 2009; Rogers et al. 2009). Thus, as earnings performance decreases the investors of firms that invest in R&D activities demand more information about those activities to better assess the amount and uncertainty of future cash flows. On the other hand, as earnings performance increases the predictive power of reported earnings increases and information asymmetry decreases, but the costs of disclosure potentially increase because better reported performance invites the attention of competitors (e.g., proprietary costs). Thus, I predict that current earnings performance is negatively related to the amount of firms' R&D-related disclosure.

Consistent with this prediction, I find that firms reporting lower (higher) earnings performance, measured by operating earnings divided by assets, provide more (less) R&D-related disclosure. This relation holds in analyses employing both firm-fixed effect and changes methodologies after controlling for a variety of disclosure determinants such as information environment, type of operations, uncertainty, and financing-related incentives. The result also holds for samples of firms with both increasing and decreasing earnings performance and using alternative measures of performance such as the

market's valuation of R&D investments, operating cash flow, and whether the firm met analysts' expectations.

To better understand the factors underlying this relation, I further investigate the role of earnings performance on R&D-related disclosure by examining when the relation between year-to-year changes earnings performance and changes in R&D-related disclosure is most pronounced. First, I predict a stronger negative relation between changes in earnings performance and changes in R&D-related disclosure for firms that place more importance on R&D investments. I measure the importance that firms place on R&D using the intensity of R&D investments and the level of industry competition. I posit that investors in these firms have greater interest in R&D information as reported performance decreases and, thus, firms have stronger incentives to provide R&D-related disclosure. My findings are consistent with this prediction.

I also predict that the relation between changes in earnings performance and changes in R&D-related disclosure is more negative for firms with higher outside monitoring in the form of financial analysts and institutional shareholders because these market participants have greater influence and access to management and can pressure firms to increase disclosure when performance is poor (Matsumoto et al. 2006). In addition, certain institutional shareholders likely demand greater disclosure because they hold large positions and bear greater costs to adjust their holdings. Consistent with this prediction, I find a significantly stronger negative relation between changes in earnings performance and changes in R&D-related disclosure for firms with higher outside monitoring.

Overall, these results suggest that current earnings performance influences firms' qualitative disclosure decisions. However, qualitative and quantitative disclosures can serve different purposes and firms' disclosure behavior in relation to these disclosures and performance could differ. For example, qualitative disclosure can help investors better understand firms' fundamental operations, while quantitative disclosure, such as earnings guidance, directly informs investors about performance. Knowing whether reported performance influences qualitative and quantitative disclosures differently improves our understanding of firms' overall disclosure strategies. While my main results suggest that current earnings performance is negatively associated with R&D-related disclosure, I find that R&D firms' decisions to provide earnings guidance, a more quantitative type of disclosure, are positively related to reported performance. These findings highlight the complexity of firms' disclosure strategies and suggest that performance can influence different types of disclosures in different ways.[7]

In addition to examining the role of performance on firms' R&D disclosure, I also consider the capital market consequences associated with these disclosures. Specifically, I find that the 10-K filings of firms with greater levels and absolute changes of R&D disclosure contain greater information content as measured by absolute stock returns around the 10-K filing date. I also document that higher levels and increases in R&D disclosure are associated with decreases in firms' relative bid-ask spreads following the 10-K filing, suggesting that R&D disclosures reduce uncertainty. These results are consistent with 10-K R&D disclosures containing meaningful information content.

[7] I also find that R&D disclosure and earning guidance associate differently with future earnings and earnings persistence (see section 4.5 for the results).

This dissertation contributes to the disclosure literature in several ways. First, prior research focuses largely on how performance influences the disclosure of *quantitative* financial information or the release of a particular type of disclosure.[8] In contrast, this study addresses management's decisions to provide *qualitative* disclosure and compares it with firms' decisions to provide more *quantitative* disclosures. Understanding how performance influences firms' qualitative disclosure decisions is particularly important because of the proportionately large amount of this information and its role in informing investors about firms' activities.

Second, while many studies control for firms' disclosure policies using measures of management earnings forecasts, the findings of this study suggest that this approach could over-generalize firms' disclosures and that researchers should also consider qualitative disclosures when studying or controlling for disclosure. This is particularly important because I find that firms' performance influences some disclosures differently and that different types of disclosure have different capital market implications. Finally, this study contributes to prior work investigating the textual features (e.g., readability and tone) of qualitative disclosures by focusing on firms' decisions to provide different amounts of R&D-related information and by providing a methodology for empirically quantifying such disclosures.

Section 2 reviews prior literature and develops my hypotheses. Section 3 describes the data and sample, and section 4 presents my empirical results. Section 5 concludes.

[8] For example, studies have examined conference calls (Frankel et al. 1999; Tasker 1999; Bowen et al. 2002), press releases (Miller 2002), and analyst disclosure ratings (Lang and Lundholm 1993). However, these studies have generally focused on the existence of specific disclosures or overall disclosure quality, rather than managements' decisions regarding the level of disclosure in a particular content area.

CHAPTER 2

PRIOR LITERATURE AND HYPOTHESIS DEVELOPMENT

In this section, I review the related disclosure and R&D literatures and develop hypotheses about the relation between R&D-related disclosure and reported financial performance as well as about the determinants of the cross-sectional variation in this relation.

2.1 Forms of Voluntary Disclosure

The separation of ownership and control in modern corporations motivates the need for managers to disclose relevant information to obtain financing from outside investors and to help current investors evaluate managerial actions. To obtain access to the public U.S. capital markets, firms must agree to be subject to securities regulations, created and enforced by the Securities and Exchange Commission (SEC). These regulations make the disclosure of certain financial information mandatory, such as audited financial statements.[9] Nevertheless, firms continue to exercise considerable discretion regarding the amount and content of disclosure within their mandatory reports.

In general, the information firms voluntarily disclose can be classified into two forms: 1) direct financial information (frequently quantitative) and 2) qualitative disclosure (i.e., narrative information of a more qualitative nature). Prior studies sometimes refer to these two forms of information as hard and soft information (Petersen 2004; Engelberg 2008; Demers and Vega 2010; Minnis 2010). A large body of analytical

[9] See Schipper [2007] for a discussion of required disclosures in financial reports.

and empirical research examines the voluntary disclosure of more direct financial information, but less is known about firms' qualitative disclosures.

Analytical studies model a firm's decision to disclose a noisy signal of firm value and consider whether the news in the signal exceeds a certain equilibrium threshold. The threshold is determined in a rational expectations framework based on either 1) the costs of disclosure or 2) investors' uncertainty about management's information (Verrecchia 1983; Dye 1985). An important result from this literature is that the likelihood that a firm voluntarily discloses a particular set of information is increasing in the news contained in the information.

However, it is also important to consider the role of mandatory disclosure. SEC regulations require that firms provide periodic mandatory disclosures and it is unclear from recent theoretical work how the news communicated in these disclosures (i.e., good vs. bad news) influences firms' decisions to provide different types and amounts of supplementary disclosures. Einhorn (2005) predicts that firms' are equally likely to provide voluntary disclosures, regardless of whether mandatory disclosures are favorable or unfavorable. However, Bagnoli and Watts (2007) predict that the likelihood of voluntary disclosure depends on the absolute magnitude of the news in the mandatory reports. In addition, under certain assumptions it can be shown that the likelihood of disclosure could vary negatively or positively with the news in mandatory reports (Duvall 1967; Baiman and Demski 1980; Hughes and Pae 2004).

Given the differences in these analytical findings, the role of performance on firms' supplementary disclosure is an open empirical question. However, the differences in the theoretical results suggest that it is important to consider the complexity of firms'

disclosure behavior and the varying incentives of the parties involved (e.g., managers, investors, or regulators). For example, while many studies suggest that better performing firms provide more disclosure, it is possible that under certain conditions firms will produce disclosures only if the reported performance is poor because the costs and benefits of additional disclosure are not necessarily symmetric for both good and bad news reports and can be asymmetric. In fact, recent empirical evidence suggests that information asymmetry is negatively associated with financial performance (Wittenberg-Moerman 2008; Brown et al 2009; Ng et al. 2009; Rogers et al. 2009).

Prior empirical studies typically focus on the disclosure of quantitative financial metrics, such as earnings guidance or segment accounting data, as opposed to more qualitative information (Patell 1976; Penman 1980; Ajinkya and Gift 1984; Lev and Penman 1990; Skinner 1994; Kasznik and Lev 1995; Harris 1998; Leuz 2004; Botosan and Stanford 2005; Berger and Hann 2007). One potential reason that qualitative disclosure receives less attention is that researchers incur higher costs to study it, particularly in large samples. Qualitative disclosure is not generally available in machine-readable format and quantifying the information it contains is more difficult and less objective. However, developments in computing technology and the advancement of the SEC's EDGAR database have reduced these costs.

Recent empirical studies examine the textual characteristics (e.g., readability or tone) of qualitative disclosures provided in conjunction with firms' mandatory disclosures and the economic consequences associated with this information. In general, these studies find that qualitative information is important and useful to market participants (Guo et al. 2004; Davis et al. 2008; Li 2008, 2010; Feldman et al. 2009;

Brown and Tucker 2010; Lehavy et al. 2010; Sun 2010). However, this research has only begun to examine the importance of qualitative disclosure, and does not provide a complete picture of when and why firms disclose different types of information.

2.2 R&D-related Disclosure

The R&D setting provides a particularly interesting area to study firms' qualitative disclosure behavior in relation to reported performance. First, accounting rules treat R&D differently than other investments. While firms periodically evaluate the values of financial and physical assets through impairment, depreciation, or mark-to-market procedures, firms must immediately expense R&D investments and there are few mandatory disclosure requirements.[10] It is also very difficult to quantify accurately the future value of R&D investments. Consequently, financial statements fail to communicate effectively the value and performance of R&D investments (Lev 1999; Lev and Zarowin 1999; Aboody and Lev 2000).

Second, R&D investment is associated with higher information asymmetry and uncertainty than more tangible investments. The unique and risky nature of R&D projects, the limited usefulness of information obtained from other firms, and the lack of well-developed markets for R&D-type assets reinforces the importance of R&D-related disclosure to investors (Aboody and Lev 2000; Boone and Raman 2001; Chan, Lakonishok, and Sougiannis 2001; Kothari, Laguerre, and Leone 2002).[11] Moreover, R&D investment is economically important. Public corporations invest hundreds of

[10] It is important to note that this generalization can depend on the presence of R&D arrangements. Current regulations require that firms disclose (1) the total R&D expenses for each income statement period presented (SFAS 2), (2) the amount of any in-process R&D acquired through acquisitions (SFAS 141 and 142), and (3) the terms of any R&D arrangements accounted for as a contract to perform R&D for others (SFAS 68).

[11] In recent years, intellectual property auctions such as Ocean Tomo have started to appear; however, the recent economic downturn and a lack of broad interest have limited the liquidity and size of these groups.

billions of dollars annually in R&D projects to create valuable products, services, and processes (Wolfe 2010). A large literature across many disciplines examines R&D funding, performance, and valuation. R&D is of particular relevance to investors, because R&D investments affect performance, expected profits, and future cash flows (Grandi et al. 2009; see Lev 2001 for a synthesis of prior research). Thus, the combination of investors' need for R&D-related information and the limitations of financial statements to convey it provides managers an important disclosure opportunity to inform investors about the fundamentals of their business activities.

Despite the importance of R&D disclosure, prior research that directly examines firms' communication of R&D information within the formal reporting context (i.e., within firms' financial reports) is limited to a small number of studies based on limited samples and industries. Entwistle (1999) examines the R&D disclosure environment of 113 technology-intensive firms listed on the Toronto Stock Exchange.[12] He performs both field interviews with executives and analysts, as well as a content analysis of the R&D-related disclosures in annual reports. His field interviews suggest that managers make cost/benefit analyses for their R&D-related disclosure decisions and that there is large variation across firms in the importance of capital and product market concerns. In addition, his content analysis suggests that R&D-related disclosure varies by industry and the amount of R&D spending.

Similarly, Jones (2007) examines the amount of R&D information provided by firms using a sample of 119 U.S. firms in four R&D-related industries. She finds that R&D-related disclosure is associated with lower analyst forecast errors for both earnings

[12] Note that the reporting requirements for Canadian firms differ from U.S. firms in that Canadian firms can choose to defer rather expense development costs (Entwhistle 1999).

and sales. Guo et al. (2004) focus on the competitive costs of disclosure by examining the product-related disclosures in the IPO prospectuses of 49 biotech companies. They find that the stage of product development, the availability of patent protection, and the presence of venture capital backing influence biotech firms' R&D-related disclosures. They also find that the amount of R&D-related disclosure is negatively associated with measures of information asymmetry.

While the generalizability of these studies is limited by their small samples and respective sample selection criteria, these studies suggest that managers can use their reporting discretion to provide important information about many different aspects of their R&D investments such as inputs (e.g., expenditure amounts, facilities, scientists, collaborations), progress of projects, outputs, and sources of funding. I extend prior research on R&D-related disclosure by examining the relation between disclosure and reported financial performance. In addition, I examine R&D-related disclosures using a large sample of firms across many different industries and base my tests on within-firm variation as well as changes in disclosure and performance.[13]

2.3 R&D-related Disclosure and Financial Performance

Motivated by theoretical models (Einhorn 2005; Bagnoli and Watts 2007), I study firms' decisions to provide qualitative R&D-related disclosure in the framework of a performance evaluation. External stakeholders (e.g., investors, competitors, or suppliers) evaluate R&D firms' reported current financial performance, relative to industry peers and prior period reports, to estimate firm value and to consider potential investment

[13] Two concurrent working papers examine firms' disclosure of R&D-related information outside of the firms' formal financial reporting. James and Shaver (2009) examine the disclosures of 302 firms in the communications and pharmaceutical industries. Their evidence suggests that firms with stronger strategic positions are more likely to provide press releases regarding R&D accomplishments. Nichols (2009) examines the disclosure of product-related and business expansion announcements. His evidence suggests that these announcements trigger positive returns that are increasing in proprietary costs.

opportunities. Variation in reported performance relative to these benchmarks influences stakeholders' demands for R&D information to complement the financial statements and influences firms' willingness to supply this information.

On the one hand, as current earnings performance decreases, reported earnings becomes less predictive of future performance, i.e., the earnings signal becomes noisier (Hayn 1995). This is particularly true for firms that invest in R&D as investors consider the causes and nature of lower performance with particular attention to R&D investments in forming expectations about firms' long-term prospects (Joos and Plesko 2005). In fact, prior research suggests that the financial statements of poorly performing R&D firms are less useful to investors (Lev and Zarowin 1999; Franzen et al. 2007). In addition, while R&D investments are already associated with high information asymmetry, this information asymmetry increases as earnings performance decreases (Wittenberg-Moerman 2008; Brown et al 2009; Ng et al. 2009; Rogers et al. 2009). Thus, as reported performance decreases the investors of firms that invest in R&D activities demand more information about those activities to better assess the amount and uncertainty of future cash flows and managers in turn are prompted to supply this information.[14]

On the other hand, as earnings performance increases the predictive power of earnings increases and information asymmetry decreases. Better current financial performance suggests that prior R&D investments have been successful and alleviates some of investors' concern about the amount and uncertainty of firms' future cash flows. However, better performance also invites competition and influences the behavior of

[14] For example, one pharmaceutical controller commented that his firm recently increased R&D disclosure significantly in an effort to obtain investment capital. This was because investors needed to understand the firm's R&D in light of the firm's recent poor performance. Similarly, several investor relations professionals from technology firms suggested that they provide additional R&D information when performance is down to keep investors on-board with their firms' longer-term strategies.

competitors and suppliers who seek opportunities to increase their own performance (Dontoh 1989, Sadka 2004). The costs of disclosure (e.g., proprietary costs) could potentially increase with earnings performance because higher performing firms could have more to lose in terms of competitive advantage. Information asymmetry between management and competing firms about the cause of higher performance and its relation to the firm's current R&D activities provides an important block to imitation and factor mobility (Lippman and Rumelt 1982, Barney 1991). Thus, providing less R&D-related disclosure when current performance is high could limit the ability of other firms to fully adjust important aspects of their operations such as pricing, production, research, advertising, or strategy. This suggests investors could demand less R&D-related disclosure when reported performance is higher and that managers could be less willingly to supply it. [15] Based on this analysis of both high and low performance, I propose the following hypothesis:[16]

H_1: Current earnings performance is negatively associated with the amount of firms' R&D-related disclosure.

My first hypothesis is consistent with the notion that as earnings performance decreases (increases), investors demand more (less) information to better evaluate their current or potential investments. However, there is likely considerable variation in the importance of this relation across firms. For example, this relation likely varies in the

[15] While it not completely clear whether 10-K information benefits firms' competitors, the author's discussions with competitive intelligence experts and industry professionals suggest that many firms are very concerned about this problem in their 10-K disclosures and that competitors read this information. For example, in one 10-K filing Medivation, a pharmaceutical firm, indicated for the first time that it was expediting its stage three trials of an Alzheimer drug. Subsequent to this release, Elan and Wyeth, working in the same area, revealed that it would expedite the trials for its own Alzheimer drug.

[16] Note that this prediction is opposite to that of the literature on more quantitative disclosures (e.g., Verrecchia 1983). The key issue is that qualitative and quantitative disclosures are different and serve different purposes. For example, I assume that qualitative R&D disclosure is used to "estimate the value implication of the content of firms' financial reports" (Bagnoli and Watts 2007, 886) as opposed to providing a direct signal about firm value.

cross-section based on the relative importance of R&D investments and the amount of outside monitoring.

My second hypothesis addresses how the relative importance of R&D investment to firms' business strategies influences the relation between earnings performance and disclosure. On the one hand, as earnings performance decreases, R&D-related information is likely to be more important to investors in firms that place a greater emphasis on R&D. I specifically refer to these firms as having high R&D priorities. On the other hand, as earnings performance increases, R&D-related information could be more important to the competitors of firms with high R&D priorities (i.e., proprietary costs) to help them to adjust their own operations. My second hypothesis is as follows:

H_2: Current earnings performance is more negatively associated with the amount of firms' R&D-related disclosure for firms with high R&D priorities as compared with firms with low R&D priorities.

Finally, I examine how the relation between R&D-related disclosure and financial performance varies based on outside monitoring. Agency concerns increase as firm reported performance decreases because managers seek to withhold information that could reveal poor managerial action or ability (Nagar 1999; Bushee and Leuz 2005; Berger and Hann 2007). In the case of R&D, poorly performing firms could be hesitant to provide R&D-related disclosure because investors could conclude that management is making poor R&D investments or lacks competence. However, outside monitors such as institutional shareholders could pressure management to make decisions that are more aligned with shareholders' interests (e.g., Bushee 1998). Thus, outside monitors can strengthen managements' response to investors when reported performance is poor by

encouraging higher disclosure (Matsumoto et al. 2006). Based on this reasoning, I make the following hypothesis:

H_3: Current earnings performance is more negatively associated with the amount of firms' R&D-related disclosure for firms with high outside monitoring as compared with firms with low outside monitoring.

CHAPTER 3

SAMPLE AND VARIABLE DEFINITIONS

3.1 Sample Selection

My initial sample is based on firm/year observations for fiscal years 1996-2007 with financial data available on the Compustat Fundamental Annual table and pricing data available from the Center for Research in Security Prices (CRSP). In addition, I require that each observation have at least one million dollars of assets, report non-zero R&D expense, and have 10-K data available from the SEC's Electronic Data Gathering, Analysis, and Retrieval system (EDGAR). I link my sample observations to EDGAR filings based on the SEC's Central Index Key (CIK). I drop firms without matches from the sample. Further, I require that each firm-year observation be a member of an industry with sufficient data to compute a measure of industry R&D payoff as well as to calculate my control variables. I provide specific details about these measures later in this section. My final sample is composed of 22,445 firm-year observations from firms that invest in R&D.

3.2 Measuring R&D-related Disclosure

I measure R&D-related disclosure based on a content analysis of 10-K filings. This measure has several advantages. First, it allows me to sample from a broad range of

industries and firms that make R&D investments. This is an improvement over prior empirical work on R&D-related disclosure that is limited to small samples and select industries. Second, this measure allows me to focus on qualitative disclosures that firms provide concurrently with accounting performance measures and reduces selection concerns because all firms with material R&D investments must provide a minimum level of disclosure in the 10-K filing. Third, prior research and private conversations with competitive intelligence professionals suggest that 10-K filings are an important source of information for market participants (e.g., Previts et al. 1994; Rogers and Grant 1997; Choudhary et al. 2010; Lehavy et al. 2010; Brown and Tucker 2010). It is important to note, however, that some firms' 10-K filings have little within-firm variation (i.e., sticky disclosure) and can contain previously disclosed information (i.e., lack of timeliness).[17]

To measure the R&D-related disclosure in 10-K filings I first develop an R&D disclosure dictionary of keywords and phrases after carefully examining by hand a random selection of over one hundred and fifty 10-K filings of firms included in my sample. In particular, I focus on keywords and phrases common across different firms' disclosures. To ensure that my keywords list is reasonable I consulted industry personnel on R&D-related disclosure topics and compared my list with examples used in Entwistle

[17] These drawbacks should work against my ability to find results. Another potential medium for R&D disclosure is firms' press releases; however, collection of this data for a large sample of firms is very costly (e.g., data collection time and copyright/legal issues with data vendors). In addition, press releases can be subject to greater selection issues because firms are generally not obligated to issue R&D-related press releases, but are required to provide minimum R&D disclosures in the 10-K. I verify that my main results are similar in direction and significance in a reduced sample of firms using the number of R&D-related press releases as a measure of R&D disclosure. In addition, using a small hand-collected sample, I find that much of the specific information in firms' R&D-related press releases is contained in 10-K filings, but that the two disclosures have some differential information.

(1999) and James and Shaver (2009). Appendix A contains the keywords that provide the basis for this dictionary approach to content analysis.[18]

I use this list of keywords and phrases along with their common variants to identify R&D-related disclosures at the sentence level using a computerized algorithm. This algorithm uses the Perl programming language's "regular expression" routines to search each 10-Ks for variations of the keywords and phrases found in Appendix A. Because it is difficult to construct measures based on subjective assessments of specific information items, I measure R&D-related disclosure ($R\&D_{DISC}$) as the number of R&D-related sentences in firm's 10-K filings.[19] Table 1 provides descriptive statistics of this measure. As shown in Panel A, the average firm discloses 30.87 R&D-related sentences. This number is likely higher than what would be anticipated if firms only disclose the minimum requirements.[20] As a benchmark, I examine the number of earnings and revenue related disclosures. As expected, the average number of R&D-related disclosures is lower than that of these other disclosure areas. However, it is still a significant amount of R&D-related disclosure given critics' contention that firms provide this information only for compliance purposes.

[18] Because any list of keywords is subjective, it is important to note that my main results continue hold in both direction and significance when using only the bolded words in Appendix A to calculate R&D disclosure. The standard errors are slightly larger, however, consistent with the notion of greater measurement error or less precision.

[19] Using this procedure, I likely measure R&D disclosure with error. Because my disclosure measure is a dependent variable in this paper, it will not bias my estimates if the error is random, but it could lead to larger standard errors. It is difficult to objectively determine whether these errors are biased. If they are, it seems reasonable to argue that this bias is most likely associated with the levels of the independent variables (i.e., firm characteristics) and not with their changes. The levels are more likely to be related to differences in the structure (i.e., word choice and syntax) of the text of firms' R&D-related disclosures.

[20] This assumes a strict interpretation of the rules and it is difficult to ascertain what the SEC would consider mandatory. For example, some firms receive comment letters from the SEC asking for additional R&D information. In general, firms respond to these requests by asserting that the information in question is proprietary and its disclosure would put the firm at a competitive disadvantage.

Panel B provides the descriptive statistics of firms' R&D-related disclosure based on industries using the Fama-French 48 classification. Consistent with prior R&D studies (Entwistle 1999), pharmaceutical firms provide the greatest amount of R&D-related disclosure, averaging about 83 R&D-sentences per 10-K. Firms in industries that create high-tech/computer products (Medical Equipment, Business Services, Electronic Equipment, Measuring and Control Equipment, and Computers) provide about 24 to 30 R&D-related sentences, on average. The remaining industries produce somewhat less R&D-related disclosure, averaging between 11 to 18 sentences.

Panel C provides statistics of the percentage of a firm's R&D-related disclosures that address specific R&D subjects. I assign a subject to an R&D-related disclosure if it contains words or phrases that relate to that particular subject. For example, an R&D-related sentence from a pharmaceutical firm could discuss the progress of current projects. I also examine the sentences directly following an R&D-related disclosure to determine its subject because these sentences often explain or elaborate on the R&D-related sentence. Appendix B provides examples of R&D-related disclosures pertaining to each subject category. I also examine whether R&D-related disclosure relates to risk (R&D Risk) or contains forward-looking statements (R&D FLS).[21]

On average, 18% of firms' R&D-related disclosure is related to explaining the risks and uncertainties associated with R&D investment. A large portion of R&D-related disclosure is about forward-looking information (17%, mostly risk-related), prior R&D

[21] I define a sentence to be risk related if it contains the following phrases or common variations: "risk," "uncertain," "could significantly affect," "may adversely affect," "success depends," "subject to," "variability," "fluctuations," "may delay," "cannot provide assurance," and "no assurance." I define a sentence to be forward-looking if it contains the future tense of words such as "will," "could", "should," "expect," "anticipate," "plan," "hope," "believe," "can," "may," "might," "intend" "project," "forecast," "objective," or "goal."

expenditures (14%), competition (12%), facilities (12%), and strategy (11%). Firms provide less information, on average, about topics such as R&D progress (5%), employees (3%), and funding (2%). Overall, these data are consistent with firms providing important information to help alleviate information asymmetry concerns, however, areas associated with information that could be valuable to competitors, such as R&D progress, receive less discussion.

3.3 Variable Definitions

Performance

I measure current earnings performance using an adjusted return-on-assets (adjROA), defined as annual operating earnings before R&D and advertising expense scaled by ending total assets, similar to Sougiannis (1994). I choose current earnings, in particular, because of the large body of evidence regarding its role as an important performance measure to investors and financial analysts. It is also important to managers either directly as a component of their compensation contract or indirectly through its relation to stock prices. In addition, earnings are a visible performance measure that receives considerable attention from investors and the financial press.[22]

Control Variables

I control for firms' information and disclosure environments, investment mix, information uncertainty, and financing incentives. Prior research suggests that firms with better information and disclosure environments (i.e., the amount and quality of information available to outsiders about the firm) provide higher levels of disclosure because these firms bear lower information production costs, have better information

[22] My inferences continue to hold using other measures of performance including the market's valuation of R&D investments, whether the firm met analysts' expectations, and cash flow from operations. These are examined in Section 4.2.

systems, greater expertise, and better monitoring (Lang and Lundholm 1993). I employ a variety of proxies to capture this construct. I measure SIZE as the logarithm of total assets, ANALYSTS as the number of analysts following the firm at the beginning of the fiscal period, and %INST as the percentage of institutional ownership at the beginning of the fiscal period. All of these variables have been found to be positively associated with firm disclosure. In addition, I control for the overall quality of firm‘s disclosures with the number of management forecasts issued during the reporting period (MFCOUNT) (Nagar et al. 2003; Lehavy et al. 2011).[23]

I control for investment mix (intangibles vs. fixed assets), because the type of investment could influence the importance of capital and product market considerations to a firm. Entwistle (1999) finds that firms with higher R&D expenditures provide higher R&D-related disclosure. Similarly, I measure the extent of a R&D investment as the ratio of R&D expense to total operating expense (R&D/OPX). I also include the book-to-market ratio (BM) as a measure of the extent of intangible assets; however, this variable could also capture aspects of proprietary cost. In addition, I include the capital intensity ratio (CAPINT) defined as the ratio of tangible assets (PP&E and inventories) to total assets. Firms with more tangible investments could have less incentive to provide R&D-related disclosures because they have higher collateral in the form of physical assets.

I also include controls for information uncertainty. Prior literature provides mixed evidence regarding the effect of information uncertainty on disclosure (Lang and Lundholm 1993). While investors prefer more disclosure when uncertainty is high,

[23] Li (2008) provides evidence that firms with lower performance can obfuscate their performance by providing less readable disclosures. I do not control for readability in my reported results because of concerns that such measures are endogenous to the R&D disclosure decision. However, in untabulated results I find that my results are consistent (e.g., similar direction and significance) after the inclusion of measures of 10-K readability.

managers could be less able to provide accurate information and could have higher disclosure costs. I control for information uncertainty using the standard deviation of monthly stock returns over the reporting period (RETVOL) and the standard deviation of earnings over the prior 3 years. These measures capture information uncertainty relating to both general performance and to the uncertainty surrounding the payoffs to R&D investments.

I include controls for financing incentives. Due to the uncertain nature of R&D investments, R&D performing firms rely on equity financing more than debt. Differences between debt and equity interests could create demands for different R&D-related disclosure information. Also, prior research suggests that firms could alter their disclosure behavior prior to issuing additional stock. As such, I include controls for leverage (LEVERAGE), measured as ratio of debt to total assets, and stock issuance (STOCK_ISS), measured as an indicator variable which equals one if the firm had a positive net equity issuance in the current year.[24]

In addition to the controls described, I also include industry and year or firm and year fixed effects to control for unobserved constant factors that relate to both performance and R&D-related disclosure but are not accounted for in my other control variables. Industry-fixed effects are particularly important because it is likely that unobservable industry factors relate to both firms' disclosure behavior and their performance. Similarly, firm-fixed effects are important because firms' disclosure policies and their performance could be related to other unobservable characteristics and could confound my inferences.

[24] Results are unchanged if I expand this variable to include the two future years as in Lang and Lundholm (1993), however, it does result in a smaller sample size and increases selection bias.

CHAPTER 4

EMPIRICAL RESULTS

4.1 Summary Statistics

Table 2 presents descriptive statistics for the sample of firm-year observations. Consistent with prior research, the distribution of the size of firms that invest in R&D measured by total sales and total assets is right skewed with means (medians) of $1,300 (94) million and $1,400 (124) million, respectively. The average (median) adjusted return-on-assets is 0.06 (0.11). The average (median) firm in my sample is followed by 4.4 (2) analysts and institutional investors own 38% (34%) of its outstanding shares. These averages are smaller than more general samples because a number of firms that invest in R&D tend to be smaller, less profitable firms. Importantly, the average (median) sample firm spends 17% (10%) of its operating budget on R&D (measured as the ratio of R&D expense to total operating expense), has a book-to-market ratio of 0.50 (0.37), and relies heavily on equity financing. The mean (median) debt-to-asset ratio (LEVERAGE) is only 17% (8%) and over 55% of sample firms had net stock issues during the fiscal year.

4.2 Reported Performance and R&D-related Disclosure

My first hypothesis concerns whether reported earnings performance negatively influences firms' decisions to provide concurrent R&D-related disclosure. To test this hypothesis I first examine the univariate correlation of current earnings performance with firms' R&D-related disclosures. Panel A of Table 3 presents the Spearman and Pearson

correlations of earnings (adjROA) with total R&D-related disclosures and also with the respective number of R&D-related disclosures on specific subjects.

Consistent with my main hypothesis, I find that earnings performance correlates negatively with total R&D-related disclosure. However, I also find that it relates positively to the quantity of 10-K earnings and revenue disclosures, consistent with these disclosures have different characteristics than R&D-related information. In addition, earnings performance is negatively related to almost all of the individual R&D subject disclosure measures. With few exceptions (e.g., R&D to Sales and In-process R&D), these correlations range from about -3% to -20%. In particular, earnings performance (adjROA) is more negatively associated with more firm specific disclosure issues such as R&D progress, patents, funding, and employees.

To further examine the common variation in the various R&D-related disclosure subjects, I perform a factor analysis on these measures, rather than examining them individually in a multivariate setting. Consistent with the previous correlation results, standard diagnostic tests (e.g., eigenvalues, percentage of variation, and scree plots) suggest the presence of a single general factor. Panel B of Table 3 provides the coefficient estimates of the factor loadings and standardized factor scores. In particular, the higher factor loadings on R&D subjects that are important to investors, such as R&D projects, patents, competition, and collaborations, suggests that these disclosures share significant common variation (i.e., they move together). This is important because individual R&D subject disclosures do not capture the entirety of firms' R&D-related disclosures and firms do not provide this information in isolation. Interestingly, I find that the factor produced by this analysis is highly correlated ($p > .90$) with the total number of

R&D sentences. Thus, in all subsequent multivariate tests, I use the number of R&D-related sentences, rather than the factor, as my R&D-related disclosure measure for ease of interpretation.

While the univariate results provide useful descriptive information, they do not control for a variety of important factors that could confound inferences regarding the relation of current earnings performance and R&D-related disclosure. Thus, I provide further evidence by estimating the following multivariate regression that includes controls for a variety of disclosure determinants examined in prior disclosure literature:

$$\begin{aligned} \mathbf{LN(R\&D_{DISC}) =}\ & \mathbf{\beta_0 + \beta_1\, adjROA + \beta_2\, SIZE + \beta_3\, ANALYSTS + \beta_4\, \%INST +} \\ & \mathbf{\beta_5\, MFCOUNT + \beta_6\, R\&D/OPX + \beta_7\, BM + \beta_8\, CAPINT +} \\ & \mathbf{\beta_9\, RETVOL + \beta_{10}\, EARNVOL + \beta_{11}\, LEVERAGE +} \\ & \mathbf{\beta_{12}\, STOCK\_ISS + fixed\ effects + \varepsilon} \qquad \mathbf{(1)}. \end{aligned}$$

The dependent variable is the natural logarithm of $R\&D_{DISC}$.[25] The estimation is performed using ordinary least squares regression. Column 1 reports the results of the estimation without fixed effects. t-statistics, presented in brackets, are based on standard errors that are clustered by firm and year. Consistent with my hypothesis, the coefficient on adjROA is -0.230 and is statistically significant ($p < .01$), suggesting that firms with lower earnings performance provide higher R&D-related disclosure.[26] This implies that a

[25] In my sample $R\&D_{DISC}$ has a skewness of 2.8, thus I use the logarithmic transformation of R&DDISC to help alleviate this issue in the regressions which follow equation 2.

[26] I cluster on time and firm following Gow et al. (2010) who find that this procedure produces more reliable rejection rates than other methods even with as few as 10 time clusters. However, given concerns about the finite sample properties of this procedure I also verify that my results remain significant at $p < .05$ based on bootstrap corrections (Cameron et al. 2008). In addition, the coefficient on adjROA continues to be negative and significant ($p < 0.01$) after the inclusion of time fixed effects in addition to industry fixed effects. I do not include time fixed effects because $R\&D_{PAYOFF}$ is based only on time and industry variation. If I replace industry fixed effects with time fixed effects, the coefficient on $R\&D_{PAYOFF}$ remains negative and significant at the 0.01 level. The same applies to the use of both firm and time fixed effects for both measures of performance and the inclusion of no fixed effects. In addition, the results remain significant at the $p < 0.05$ level regardless of the method of clustering.

standard deviation decrease in adjROA is associated with about a 5.5% increase in R&D-related disclosure.

The signs of the coefficients on the control variables are similar to those reported in prior disclosure literature. Firms with better information environments as measured by SIZE, %INST, and MFCOUNT provide more R&D-related disclosure (however, the coefficients on ANALYSTS is insignificant). I also find that firms with higher investment in innovation (as measured by R&D/OPX and MB) and lower amounts of fixed capital provide more R&D-related disclosure. Finally, less leveraged firms and firms with recent net stock issuances provide more R&D-related disclosure.

While the evidence in column 1 suggests performance is negatively associated with R&D-related disclosure, it is possible that there are time invariant factors that have not been properly controlled for. To help mitigate this possibility, I estimate the previous regression model first with industry and year fixed effects and second with firm and year fixed effects. As shown in columns 2 and 3, the sign and significance of the coefficients on adjROA is largely unchanged. These results based on within-firm variation provide stronger evidence that firms provide R&D-related disclosure in response to the demands of investors based on current performance.[27]

While my results based on within-firm variation support the prediction of a negative relation between R&D-related disclosure and performance, the firm-fixed effect approach assumes that the influence of current performance on firms' R&D-related disclosure varies based on firm averages. In other words, the firm fixed effect results

[27] I continue to find a negative and statistically significant relation ($p < 0.05$) when using alternative measures of performance such as the return from net income or cash flow from operations. In addition, the sign and significance of my results are unchanged if I include additional controls for in-process R&D expenditures or general acquisition costs. Similarly, my inferences are unchanged if I limit the sample to firm-years with zero in-process R&D or firm-years without mergers and acquisitions.

address the question of how firms use R&D-related disclosure to respond to performance as it differs from their average performance. However, it is also important to consider how R&D-related disclosure varies as performance *changes* relative to prior year performance. In fact, the relation between changes in performance and changes in R&D-related disclosure relates more strongly to idea that managers provide R&D-related disclosure in response to changes in performance. Thus, I estimate the following changes regression:

$$\Delta R\&D_{DISC} = \beta_0 + \beta_1 \Delta adjROA + \beta_2 \Delta SIZE + \beta_3 \Delta ANALYSTS + \beta_4 \Delta \%INST + \beta_5 \Delta MFCOUNT + \beta_6 \Delta(R\&D/OPX) + \beta_7 \Delta CAPINT + \beta_8 \Delta RETVOL + \beta_9 \Delta EARNVOL + \beta_{10} \Delta LEVERAGE + \beta_{11} STOCK\_ISS + \text{year fixed effects} + \varepsilon \quad (2),$$

where the dependent variable is the year-to-year change in $R\&D_{DISC}$ and the independent variables are also year-to-year changes of those used in equation 1 with the exception of STOCK_ISS.[28] I perform this estimation using ordinary least squares. t-statistics, presented in brackets, are based on standard errors that are clustered on firm and year.[29] Column 1 of Table 5 reports the results of the regression estimation. Consistent with my hypothesis and previous results, the coefficients on ΔadjROA is negative and significant. This result is particularly important because a large body of disclosure-based work focuses on cross-sectional regressions of levels variables where there are more severe

[28] Note that the dependent variable does not incorporate the logarithmic transformation because the $\Delta R\&D_{DISC}$ does exhibit skewness. I do not use the change in STOCK_ISS because the issuance of stock is a represents a potential change in the firms' capital structure.

[29] While the changes regression model differences out the levels effects of individual years, I continue to cluster my estimates by year to account for changes associated with effects common to individual years. My inferences do not change if I cluster only at the firm level or use bootstrapping techniques. In addition, the coefficient on ΔadjROA continues to be negative and significant after the inclusion of year fixed effects. However, similar to the previous regressions, I do not include year fixed effects because the $\Delta R\&D_{PAYOFF}$ measure is based only on time variation and the industry variation is differenced out in the changes.

concerns about correlated omitted variables. My evidence suggests that changes in earnings performance are negatively associated with changes in R&D-related disclosure.

Next, I examine whether the results based on changes in earnings performance (adjROA, in Table 5 column 1) differ based on the sign of the earnings change to determine whether the relationship between R&D-related disclosure and earnings performance is different for samples with increasing or decreasing performance. Columns 2 and 3 of Table 5 provide the estimation of equation 2 for samples of earnings increases and earnings decreases, separately. I find that the negative relation between changes in earnings performance and changes in R&D-related disclosure is significant for both samples. While the coefficient on adjROA is more negative for the sample of earnings decreases, I find no evidence that the relation is statistically different for earnings increases or decreases in a fully interacted model. These results suggests that my findings are not driven solely by poorly performing firms that could provide R&D disclosures to downplay poor current performance.

In addition, I also consider whether my results are robust to alternative measures of changes in performance. First, I construct a market-based measure of industry R&D payoff examined in Grandi, Hall, and Oriani (2009) that is well established in the economics literature.[30] This measure estimates the payoff to R&D investment by examining how a firm's R&D capital maps into Tobin's Q based on an empirical model.

[30] See Griliches 1981; Jaffe 1986; Cockburn and Griliches 1988; Hall 1993; Hall, Jaffe, and Trajtenberg 2005; Hall and Oriani 2006 for examples of this measure. While stock returns also provide a measure of market performance, they can be particularly noisy and long window returns may not relate well to firms' disclosure choices at a particular moment in time. Consistent with this assertion, I find no evidence of an association between current annual returns and firms' R&D disclosure.

To compute this measure I estimate the value of γ ($R\&D_{PAYOFF}$) in the following equation using nonlinear least squares for each industry and year:[31]

$$\ln\left(\frac{V_{i,t}}{A_{i,t}}\right) = \ln b + \ln(1 + \frac{\gamma K_{i,t}}{A_{i,t}}) \quad \textbf{(3)},$$

where *V* is a firm's market value three months after the fiscal period end, *K* is a firm's tangible assets (PP&E and inventories), and *A* is a firm's R&D capital based on the capitalization and amortization of R&D expenditures at a rate of 20% following Lev and Sougiannis (1996) and Chen, Lakonishok, and Sougiannis (2001). The estimate of γ is interpreted as the differential valuation of R&D capital relative to tangible assets.

I also examine how changes in cash flow from operations relate to changes in R&D disclosure as well as whether a firm's reported earnings meet or beat the analyst consensus forecasts. I measure changes in cash flow (ΔCF) as year-to-year changes in cash flow from operations scaled by total assets. I define ΔMeet or Beat as an indicator variable that equals 1 if the firms' earnings exceed the median analyst forecast prior to the earnings announcement following Livnat and Mendenall (2006) to adjust for stock splits.[32]

The results of the estimation using these alternative measures of performance are presented in Table 6. Similar to the previous results, I find that changes in performance are negatively associated with changes in R&D disclosure using all three alternative measures. Overall, my evidence is consistent with the assertion that firms change their R&D-related information based on changes in reported performance.

[31] See Grandi, Hall, and Oriani (2009) for specific details regarding the derivation of the empirical model. I require at least 20 observations for each industry-year regression. Note that I estimate the measure by industry-year because a firm specific measure would lack variation across time and this variation is important for identification purposes in my empirical tests.

[32] Note that the sample size for the regression using Δ Meet or Beat is smaller because it requires that the firm have analyst following.

4.3 Tests of Variation in the Relation between Reported Performance and R&D Disclosure

My second and third hypotheses suggest that the strength of the negative relation between changes in earnings performance and changes in R&D-related disclosure differs based on cross-sectional firm characteristics. The second hypothesis states that the negative relation between changes in current earnings performance and changes in R&D-related disclosure is stronger for firms that place more importance on R&D investment, that is, high R&D priority firms. To identify firms with high R&D priorities, I partition my sample based on specific firm and industry characteristics. First, I measure the importance of a firm's R&D based on the percentage of its operating budget spent on R&D investment. This measures how important R&D is as a component of a firms' operating budget. Second, prior research suggests that firms in more concentrated industries face more intense competition and that innovation is increasingly important for firms facing more intense competition. Thus, I measure industry competition using the four-firm concentration ratios provided by the U.S. data based on three digit NAICS codes (Ali, Klasa, and Yeung 2008).

I partition my sample firms into high and low R&D priority groups based on whether they are above or below the sample medians of both of these measures. I then estimate separate regressions for each group based on the changes regression model from equation 2. I present the estimation results for each group separately because the coefficient estimates of the groups likely differ considerably for both changes in performance and changes in the control variables. I determine the statistical significance of the coefficients across the two groups using a fully-interacted model. Table 7 reports the results from this analysis. Consistent with my hypothesis, I find that the relation

between changes in adjROA and changes in R&D-related disclosure is significantly more negative for the high R&D priority group. In fact, a given change in adjROA for the high R&D priority group is associated with change in R&D-related disclosure that is more than three times greater than that of the low priority group. This evidence suggests that the importance of R&D to firms' operations plays an important role in how firms provide R&D-related disclosure in response to reported performance.

My third hypothesis asserts that outside monitoring affects the relation between changes in earnings performance and changes in R&D-related disclosure by pressuring managers to disclose more when reported performance is lower. Specifically, I predict that the negative relation between changes in current earnings performance and changes in R&D-related disclosure is stronger for firms with higher outside monitoring. Using analyst following and the percentage of institutional ownership as measures of external monitoring (Bushee 1998), I partition my sample into high and low outside monitoring groups. I denote observations with above the median analyst following and institutional ownership as the high monitoring group and those below as the low monitoring group. I then estimate separate regressions for each group based on the changes regression model from equation 2.

Table 8 presents the results from this analysis.[33] Consistent with my prediction, I find that the relation between changes in adjROA and changes in R&D-related disclosure is more negative for the high monitoring group. In particular, the influence of a change in adjROA on R&D-related disclosure for firms in the high outside monitoring group is just

[33] The high and low groups for each table are based on two independent splits using a different set of variables for each table. Thus, the number of observations in Tables 6 and 7 are different.

less than double that of the low group. The significance of this difference is based on a fully interacted regression between the two groups.

I perform additional cross-sectional tests by examining the sensitivity of the negative relation between current performance and R&D-related disclosure based on financing incentives. Lang and Lundholm (1993) suggest that firms provide better disclosure prior to seasoned equity offerings. Thus, a negative relation between performance and R&D-related disclosure may be the result of poor performing firms seeking additional financing. I partition my sample into two groups based on whether a firm had a positive net stock issuance in the two years following the 10-K filing. While the relation between current earnings performance and R&D-related disclosure is more negative in the sample of firms without net stock issuances, this difference is not statistically significant. I also find similar results for partitions of my sample based on net debt issuance, negative cash flow from operations, and changes in total cash holdings. In the interest of brevity, I do not tabulate these results.

4.4 Differences between Qualitative and Quantitative Disclosure

The primary results indicate that as earnings performance decreases, firms provide more R&D-related disclosure. In contrast, prior research suggests that firms with higher performance are more likely to provide quantitative disclosures such as annual earnings guidance to communicate performance to market participants (e.g., Patel 1976; Penman 1980; Waymire 1984; Lev and Penman 1990; Miller 2002; Houston, Lev, and Tucker 2010). However, qualitative and quantitative disclosures can serve different purposes and earnings performance could influence them differently. For example, quantitative disclosures such as earnings guidance directly inform investors about performance, while qualitative disclosures can help investors understand firms'

fundamental operations. In addition, earnings performance can also relate to investors demand for different types of disclosure through its influence on the quality of managers' information. In the case of earnings guidance, it is increasingly difficult for management to provide useful and accurate earnings projections as earnings performance decreases due to increased uncertainty (Chen et al. 2010). Thus, qualitative disclosure provides a useful disclosure alternative as earnings performance decreases to meet investors information demands. Specifically, I examine the relation between firms' earnings performance and their decisions to provide future earnings guidance in my sample.

Following prior research, I estimate a logistic regression based on the disclosure determinants previously explained for my sample of R&D performing firms. I also estimate this regression using OLS with firm and year fixed effects. Table 9 provides the results of this estimation. Consistent with prior research, I find that adjROA is positively associated with the likelihood that a firm provides earnings guidance in the coming year. Thus, while adjROA is negatively associated with R&D-related disclosures, it is positively associated with firms' decisions to provide earnings guidance. This result is consistent with the notion that qualitative R&D-related disclosure and earnings guidance relate to performance differently. While some studies measure disclosure based solely on whether a firm provides earnings guidance, my results suggest that this approach likely over-generalizes disclosure policies to only the more quantitative aspects of disclosure and overlooks the significant amount of disclosure that is more qualitative in nature.

4.5 Capital Market Consequences of 10-K R&D Disclosure

The primary results of this dissertation examine the role of performance as a determinant in firms' R&D disclosure decisions under the assumption that R&D is valuable to investors and other stakeholders. In this section, I consider the capital market

consequences of firms' 10-K R&D disclosures. Specifically, I consider the relation of R&D disclosure to the information content of 10-K filings measure through stock returns, future earnings, and relative bid-ask spreads.

I begin by examining how R&D disclosure relates to absolute market-adjusted stock returns as opposed to signed returns because it is not clear ex ante whether R&D disclosures contain on average good or bad news. I calculate the cumulative market adjusted stock return in the (-1,+1) event window centered on the 10-K filing date by summing the daily differences between the total return and the value-weighted market return. I then measure information content as the absolute value of this cumulative return. In particular, I am interested in whether the level and/or changes in R&D disclosure are associated with greater 10-K information content. Note that because it is not clear whether increase or decreases in R&D disclosure communicate good or bad news, I use the absolute value of R&D disclosure changes.

In addition, I include controls for the absolute value of the cumulative market-adjusted return centered on the earnings announcement (EA_{Return}) as well as the absolute level of adjusted earnings (adjROA) and absolute change in adjusted earnings (ΔadjROA). I include these variables for two reasons: 1) I expect the 10-K to contain greater information content when there is more news in earnings because it contains important details for investors to evaluate earnings information and 2) prior research on post earnings announcement drift suggests that prices do not fully impound all available information at the time of the earnings announcement (You and Zhang 2009). I also include the natural logarithm of a firm's market capitalization (MC) and book-to-market ratio (B/M) at the end of the fiscal period as measures of firms' information environment.

In addition, I also include the number of sentences in a firm's 10-K (10-K Length), a comparison measure of disclosure as a control for other firm disclosures and also include year fixed effects.

Table 10 provides the results. t-statistics are based on standard errors that clustered by both firm and year. The positive coefficient on $Ln(R\&D_{DISC})$ suggests that the 10-K filings of firms with greater levels of R&D disclosure contain greater information content. Similarly, the 10-Ks of firms with greater absolute changes in R&D disclosure are associated with greater information content. The coefficients on $abs(EA_{Return})$ and abs(ΔadjROA) are positive and significant suggesting that 10-Ks contain greater information content when there is greater information in earnings. The coefficient on log(MC) is negative and significant which is consistent with the findings of prior literature that the disclosures of larger firms generally provide less new information to investors and that these firms have better information environments. It is also interesting to note that coefficient on 10-K Length is not significant and that of abs(Δ10-K Length) is small and only marginally significant. This suggests that my measure of 10-K R&D disclosure is different from measures of total 10-K disclosure or length.[34]

The preceding results suggests that 1) firms provide more R&D disclosure as performance decreases, 2) R&D disclosure contains information content. However, these results do not speak directly to the question of whether firms' benefit from complying with investors demand for R&D disclosure. To address this issue I consider the relation between R&D disclosure and firms' relative bid-ask spreads using both a levels and a

[34] I also find similar results using the measures of the level and absolute changes of 10-K earnings and sales disclosures from Table 1 as controls. The coefficients on 10-K Sales disclosures are not significant in any of the results and that of 10-K earnings disclosures is negative, suggesting that 10-K with such disclosures contain less information content.

changes approach. First, I examine the relation between the level of R&D disclosure and the average daily level of firms' relative bid-ask spread in the window (+2, +5) following the 10-K filing. I use the post event window to allow sufficient time for the market to process any information contained in the 10-K filing. I include the level of adjusted earnings, market capitalization, book-to-market ratio, and length of 10-K as control variables. Following Choudhary, Merkley, and Schloetzer (2011), I also include a measure of 10-K timeliness computed as the number of days that a firm makes its 10-K filing prior to the statutory deadline mandated by the SEC. Panel A of Table 11 presents the results. The coefficient on $Ln(R\&D_{DISC})$ is negative and significant suggesting that firms that provide higher R&D disclosure have lower bid-ask spreads. However, because these results are likely associated with firm characteristics in the form of correlated omitted variables, I also consider a changes approach.

Specifically, I examine the relation between year-to-year changes in R&D disclosure and the change in the average daily level of firms' relative bid-ask spread calculated as the difference in this average in the post event window (+2, +5) and the pre event window (-49, -5).[35] I include the market adjusted return from the 10-K event window to control for changes in other information contained in the 10-K filing. In addition, I include controls for changes in adjusted earnings, changes in 10-K length, and change in 10-K timeliness measured as previously explained. Panel B presents the results. Consistent with the levels results, I find that changes in R&D disclosure are negatively related to changes in bid-ask spreads. Consistent with Choudhary et al. (2011), I also find that changes in 10-K timeliness are negatively associated with bid-ask spreads. I do not,

[35] This pre-event window is also used by Asthana et al. (2004) and Miller (2010) to measure trading abnormal trading volume.

however, find evidence that changes in 10-K length are associated with changes in bid-ask spreads.

CHAPTER 5

CONCLUSION

This study emphasizes the role of qualitative disclosure as an important mechanism to help bridge the gap between more direct financial information, such as financial statements or earnings guidance, and the economic reality of firms' operations (Glassman 2003). In particular, the results provide new empirical evidence on the relation between reported performance and qualitative disclosures in a specific setting – firms' R&D-related disclosures. The R&D setting is provides a particularly informative research area because it emphasizes the importance of qualitative disclosure to external stakeholders, who need to evaluate the levels of risk and information asymmetry associated with the outcome of R&D investments. In addition, the limitations of financial statements to capture the value of R&D investments provide additional impetus to gain better insight into firms' qualitative disclosure decisions.

I find that current earnings performance is negatively related to concurrent R&D-related disclosure in both firm-fixed effect and changes regression analyses. I also find that this negative relation is a function of both the importance of R&D to the firm and the degree of outside monitoring. In contrast to my main results, I find that firms' decisions to provide earnings guidance are positively related to current performance. These findings highlight the complexity of firms' disclosure strategies and suggest that performance influences can influence the way firms' disclosure different types of differently. While there are certainly limitations in the empirical measures and design

common to this literature, my study provides important evidence regarding how managers use qualitative disclosure based on changes in performance to respond to investors.

Additionally, this study provides relevant empirical evidence regarding the complimentary relation between mandatory disclosure (e.g., financial statements) and voluntary disclosure and builds on the predictions of prior disclosure theory (Hughes and Pae 2004; Einhorn 2005; Bagnoli and Watts 2007). Prior empirical evidence suggests that mandatory disclosure serves a confirmatory role and increases the credibility of voluntary disclosure (e.g., earnings guidance) because audited financial statements will subsequently be released (Beniluz 2004; Ball et al. 2010). This study examines a different complimentary relation, namely how the information in mandatory reports relates to firms' decision to provide more or less qualitative disclosure. The results suggest that the importance of qualitative information as a complement to the financial statements depends on concurrently reported performance.

TABLES

TABLE 1

Descriptive Information on R&D-related Disclosure

This table provides descriptive information about the R&D-related disclosure measure calculated as the number of 10-K sentences that refer to R&D-related information. A sentence is determined to be R&D-related if it contains a keyword or related phrase from the dictionary of keywords found in Appendix A. Panel A provides statistics on the overall R&D-related disclosure measure and benchmarks it against a comparable score for earnings and revenue disclosures. Panel B provides descriptive information about R&D-related disclosure for selected industries. Industries are based on the Fama and French 48 classification. Panel C provides information regarding the average percentage of firms' R&D-related sentences that address specific subjects. Subjects are identified by examining the words contained within each R&D-related sentence. Panel D provides R&D disclosure subject information by industry.

Panel A. 10-K R&D-related Disclosures (N=22,445)

Variable	Mean	Median	Std Dev
10-K R&D Disclosures	30.87	20	34.64
10-K Earnings Disclosures	51.77	42	34.07
10-K Revenue Disclosures	108.50	98	56.71

Panel B. 10-K R&D-related Disclosure by Industry

Industry	N	Mean	Median	Std Dev
Pharmaceutical Products	3,204	83.42	70.00	55.95
Medical Equipment	1,775	29.95	26.00	19.16
Business Services	3,691	27.83	24.00	23.38
Electronic Equipment	2,886	26.82	24.00	16.77
Measuring and Control Equipment	1,176	26.09	22.00	16.67
Computers	2,019	24.08	22.00	14.75
Chemicals	643	18.43	13.00	20.66
Electrical Equipment	446	16.66	10.00	17.51
Machinery	1,358	15.85	11.00	12.62
Other	4,753	13.96	10.00	13.71
Auto	494	11.89	9.00	11.08

TABLE 1
(CONTINUED)
Descriptive Information on R&D-related Disclosure

Panel C. Subject of 10-K R&D-related Disclosures (N=22,445)

Variable	Mean	Median	Std Dev
%R&D RISK	0.18	0.18	0.14
%R&D FLS	0.17	0.17	0.13
%R&D to Prior Periods	0.14	0.09	0.15
%R&D Competition	0.12	0.10	0.11
%R&D Facilities	0.12	0.09	0.12
%R&D Strategy	0.11	0.09	0.11
%R&D to Operations	0.07	0.04	0.08
%R&D to Sales	0.06	0.00	0.10
%R&D Collaboration	0.05	0.00	0.10
%In-process R&D	0.04	0.00	0.11
%Patents	0.05	0.01	0.07
%R&D Progress	0.05	0.00	0.09
%R&D Employees	0.03	0.00	0.06
%R&D Funding	0.02	0.00	0.04
%R&D Tax Credit	0.02	0.00	0.04
%Regulation	0.01	0.00	0.02
%R&D Market	0.00	0.00	0.01

TABLE 2
Sample Descriptive Statistics

This table provides descriptive statistics for the overall sample of 20,990 firm-year observations. The adjROA is defined as operating income before R&D and advertising expense scaled by ending total assets. ANALYSTS is the number of analysts following the firm at the fiscal period end. %INST is the percentage of institutional ownership at the fiscal period end. MFCOUNT is the number of management forecasts issued during the fiscal period. R&D/OPX is the ratio of R&D expense to total operating expense. BM is the ration of book value to market value at the end of the fiscal period. CAPINT is the ratio of PP&E and inventories to total assets. RETVOL is the standard deviation of monthly returns during the fiscal period. EARNVOL is the standard deviation of earnings over the past three years. LEVERAGE is the ratio of total debt to total assets. STOCK_ISS is an indicator variable coded to 1 if the firm had a positive net stock issuance during the fiscal period and zero otherwise.

Variable	Mean	Median	Std Dev
adjROA	0.06	0.11	0.24
Sales ($mil)	1,300	94	4,200
Total Assets ($mil)	1,400	124	4,600
ANALYSTS	4.40	2.00	6.03
%INST	0.38	0.34	0.32
MFCOUNT	1.49	0.00	2.72
R&D/OPX	0.17	0.10	0.21
BM	0.50	0.37	0.52
CAPINT	0.29	0.27	0.20
RETVOL	0.19	0.15	0.13
EARNVOL	0.15	0.06	0.24
LEVERAGE	0.17	0.08	0.23
STOCK_ISS	0.55	1.00	0.50

TABLE 3

R&D-related Disclosure Subjects and Reported Performance

This table provides descriptive information about the role of the components of the R&D-related disclosure measure based on the subject matter of individual sentences. The subject matter is identified based on the inclusion of keywords or phrases in each sentence (see Appendix B for examples). Panel A provides Pearson and Spearman correlations for the association of adjROA with the total number of sentences for each subject area. Panel B provides the factor loading coefficients from a factor analysis of the common variation contained in the number of sentences provided in each subject area.

Panel A. Univariate Correlation of Earnings Performance and R&D-related Disclosure

Variable	Pearson	Spearman
Overall Disclosures		
Total 10-K R&D Disclosures	-0.1214*	-0.1234*
10-K Earnings Disclosures	0.2878*	0.3395*
10-K Revenue Disclosures	0.0741*	0.0660*
R&D Disclosure Categories		
R&D to Prior Periods	-0.0872*	-0.1002*
R&D Competition	-0.0974*	-0.1010*
R&D Facilities	-0.0548*	-0.0629*
R&D Strategy	-0.0827*	-0.0982*
R&D to Operations	-0.0458*	-0.0532*
R&D to Sales	0.1476*	0.2028*
R&D Collaboration	-0.0578*	-0.1574*
In-process R&D	0.0697*	0.0851*
Patents	-0.1675*	-0.1968*
R&D Progress	-0.1112*	-0.1584*
R&D Employees	-0.0552*	-0.0755*
R&D Funding	-0.1002*	-0.1648*
R&D Tax Credit	-0.0163*	-0.0514*
Regulation	-0.0927*	-0.1334*
R&D Market	-0.0281*	-0.0342*

* indicates significance at the 0.05 level or lower.

TABLE 3
(CONTINUED)
R&D-related Disclosure Subjects and Reported Performance

Panel B. Factor Analysis of R&D-related Disclosure Subject Variables

Variable	Factor Loading	Standardized Factor Score
R&D to Prior Periods	0.5873	0.0866
R&D Competition	0.7900	0.1604
R&D Facilities	0.6711	0.0945
R&D Strategy	0.7497	0.1167
R&D to Operations	0.6198	0.1012
R&D to Sales	-0.0064	0.0114
R&D Collaboration	0.8019	0.1679
In-process R&D	0.1763	0.0238
Patents	0.7130	0.1070
R&D Progress	0.8355	0.2121
R&D Employees	0.3449	0.0428
R&D Funding	0.7194	0.1009
R&D Tax Credit	0.3181	0.0351
Regulation	0.5896	0.0591
R&D Market	0.2904	0.0233

TABLE 4
R&D-related Disclosure and Reported Performance

This table reports the coefficient estimates of a regression of R&D-related disclosure on current performance. The dependent variable is the natural logarithm of the R&D-related disclosure score as defined in Table 1. SIZE is the natural logarithm of total assets. All other variables are defined in Table 2. t-statistics (in brackets) are based on standard errors that are clustered as indicated in the table.

	Variable	(1)	(2)	(3)
	Intercept	2.601***	1.863***	2.035***
		[33.10]	[26.55]	[31.71]
Performance	adjROA	-0.230***	-0.150***	-0.126***
		[-3.23]	[-3.17]	[-4.85]
Information Environment	SIZE	-0.009	0.033***	0.130***
		[-1.04]	[4.26]	[11.48]
	ANALYSTS	0.006**	0.005**	-0.002
		[2.56]	[2.48]	[-0.99]
	%INST	0.283***	0.088*	-0.039
		[5.03]	[1.90]	[-1.12]
	MFCOUNT	0.014**	0.005	-0.001
		[2.42]	[1.41]	[-0.53]
Investment Type	R&D/OPX	2.621***	1.960***	0.596***
		[33.67]	[35.43]	[11.16]
	BM	-0.094***	-0.059***	-0.004
		[-4.01]	[-2.76]	[-0.47]
	CAPINT	-0.781***	-0.496***	-0.009
		[-11.46]	[-7.82]	[-0.14]
Uncertainty	RETVOL	0.306**	0.549***	0.090***
		[2.23]	[7.26]	[3.12]
	EARNVOL	-0.050	0.025	0.079***
		[-1.49]	[0.90]	[3.70]
Financing	LEVERAGE	-0.106**	-0.087*	0.027
		[-2.16]	[-1.96]	[1.25]
	STOCK_ISS	0.120***	0.086***	0.028***
		[7.64]	[6.36]	[3.44]
Fixed Effects		No	Industry and Year	Firm and Year
Standard Error Clustering		Firm and Year	Firm and Year	Firm
Observations		22,445	22,445	22,445
Adjusted R-squared		49.6%	58.7%	88.5%

*** p < 0.01, ** p < 0.05, * p < 0.1

TABLE 5

Changes in R&D-related Disclosure and Changes in Reported Performance

This table reports the coefficient estimates of a regression of year-to-year changes in R&D-related disclosure on changes in current performance. The dependent variable is the year-to-year change in the R&D-related disclosure score. All other variables are defined as the current year-to-year changes of the variables used in Table 4. t-statistics (in brackets) are based on standard errors that are clustered on firm and time.

	Variable	All Firms	ΔadjROA > 0	ΔadjROA < 0
	Intercept	-3.802***	-4.028***	1.714***
		[-19.93]	[-15.12]	[13.10]
Performance	ΔadjROA	-2.812***	-1.827**	-3.511***
		[-3.14]	[-2.15]	[-2.70]
Information Environment	ΔSIZE	2.992***	3.274***	2.774***
		[9.46]	[8.46]	[5.56]
	ΔANALYSTS	0.055	0.061	0.028
		[0.98]	[1.05]	[0.44]
	Δ%INST	-0.554	-0.709	-0.383
		[-0.66]	[-0.84]	[-0.31]
	ΔMFCOUNT	0.010	-0.016	0.046
		[0.34]	[-0.73]	[0.80]
Investment Type	Δ(R&D/OPX)	15.340***	28.215***	6.620**
		[7.81]	[9.12]	[2.52]
	ΔCAPINT	2.912**	5.706***	0.236
		[2.08]	[2.72]	[0.17]
Uncertainty	ΔRETVOL	-0.237	-0.011	-0.449
		[-0.23]	[-0.01]	[-0.60]
	ΔEARNVOL	0.683	1.340*	0.251
		[1.10]	[1.79]	[0.39]
Financing	ΔLEVERAGE	0.971**	0.815	1.032***
		[2.46]	[0.92]	[2.75]
	STOCK_ISS	0.107	0.040	0.128
		[0.68]	[0.17]	[0.72]
Observations		19,284	9,402	9,882
Adjusted R-squared		2.7%	5.1%	1.8%

*** p < 0.01, ** p < 0.05, * p < 0.1

TABLE 6

Changes in R&D-related Disclosure and Alternative Measures of Changes in Performance

This table reports the coefficient estimates of a regression of year-to-year changes in R&D-related disclosure on changes in alternative measures of current performance. The dependent variable is the year-to-year change in the R&D-related disclosure score. ΔCF is the year-to-year change in cash flow from operations scaled by total assets. ΔMeet or Beat is an indicator variable equal to one if the firm's earnings met or exceed the most recent consensus analyst earnings forecast prior to the earnings announcement. All variables are the same as in Table 5. t-statistics (in brackets) are based on standard errors that are clustered on firm and time.

	Variable	(1)		(2)
	Intercept	1.079***	-4.254***	2.699***
		[5.47]	[-18.79]	[12.05]
Performance	$\Delta R\&D_{PAYOFF}$	-0.234*		
		[-1.87]		
	ΔMeet or Beat		-2.244***	
			[-2.89]	
	ΔCF			-0.538***
				[-3.02]
Information Environment	ΔSIZE	2.485***	3.116***	3.384***
		[8.95]	[9.03]	[5.94]
	ΔANALYSTS	0.075	0.051	0.003
		[1.31]	[0.91]	[0.05]
	Δ%INST	-0.547	-0.656	-1.323
		[-0.56]	[-0.78]	[-1.24]
	ΔMFCOUNT	0.029	0.013	0.022
		[0.91]	[0.42]	[0.65]
Investment Type	Δ(R&D/OPX)	14.284***	13.662***	15.569***
		[6.73]	[6.05]	[5.12]
	ΔCAPINT	3.147**	2.477*	3.543
		[2.20]	[1.75]	[1.62]
Uncertainty	ΔRETVOL	-0.675	-0.127	-0.453
		[-0.79]	[-0.12]	[-0.25]
	ΔEARNVOL	0.912	0.921	2.042*
		[1.53]	[1.46]	[1.85]
Financing	ΔLEVERAGE	1.308***	0.904**	0.657
		[2.90]	[2.21]	[0.59]
	STOCK_ISS	0.167	0.108	0.013
		[1.04]	[0.67]	[0.05]
Observations		18,773	19,276	10,485
Adjusted R-squared		2.2%	2.6%	2.6%

*** p < 0.01, ** p < 0.05, * p < 0.1

TABLE 7
The Influence of R&D Priorities

This table examines how the importance that firms' place on R&D influences the relation between changes in performance and changes in R&D-related disclosure. The sample firms are partitioned into high and low R&D priority groups based on the median sample values of the ratio of R&D expenditures to operating expenses and industry four-firm concentration ratios. All variables are the same as in Table 5. t-statistics (in brackets) are based on standard errors that are clustered on firm and time. The statistical significance of the coefficients on changes in the measures of performance is determined by a fully-interacted regression.

		R&D Priorities		
	Variable	High	Low	Difference
	Intercept	2.922***	0.603***	
		[12.84]	[6.85]	
Performance	ΔadjROA	-4.692**	-1.570**	-3.122**
		[-2.33]	[-2.07]	[-2.07]
Information Environment	ΔSIZE	4.331***	2.321***	
		[6.43]	[8.81]	
	ΔANALYSTS	0.055	-0.005	
		[0.27]	[-0.10]	
	Δ%INST	-1.579	-1.382**	
		[-0.91]	[-2.10]	
	ΔMFCOUNT	0.185	-0.022	
		[1.33]	[-0.66]	
Investment Type	Δ(R&D/OPX)	16.192***	20.714***	
		[6.12]	[3.61]	
	ΔCAPINT	6.320	-1.176	
		[1.47]	[-0.81]	
Uncertainty	ΔRETVOL	0.081	-0.167	
		[0.03]	[-0.35]	
	ΔEARNVOL	2.052*	1.115	
		[1.85]	[1.12]	
Financing	ΔLEVERAGE	1.599	0.084	
		[1.46]	[0.16]	
	STOCK_ISS	0.328	0.127	
		[0.68]	[0.75]	
Observations		3,939	4,234	
Adjusted R-squared		3.3%	2.8%	

*** p < 0.01, ** p < 0.05, * p < 0.1

TABLE 8
The Influence of Outside Monitoring

This table examines how outside monitoring influences the relation between changes in performance and changes in R&D-related disclosure. The sample firms are partitioned into high and low monitoring groups based on the median sample values for analyst following and institutional ownership. All variables are the same as in Table 5. t-statistics (in brackets) are based on standard errors that are clustered on firm and time. The statistical significance of the coefficients on changes in the measures of performance is determined by a fully-interacted regression.

		Outside Monitoring		
	Variable	High	Low	Difference
	Intercept	0.899***	-3.960***	
		[5.13]	[-12.32]	
Performance	ΔadjROA	-4.969***	-2.780***	-2.189**
		[-3.18]	[-3.15]	[-2.20]
Information Environment	ΔSIZE	3.854***	2.548***	
		[5.30]	[6.44]	
	ΔANALYSTS	0.014	0.121	
		[0.23]	[1.16]	
	Δ%INST	-0.886	-0.842	
		[-0.89]	[-0.32]	
	ΔMFCOUNT	-0.012	-0.014	
		[-0.33]	[-0.20]	
Investment Type	Δ(R&D/OPX)	21.103***	12.747***	
		[9.14]	[7.14]	
	ΔCAPINT	4.892	2.126	
		[1.47]	[1.39]	
Uncertainty	ΔRETVOL	-2.425	-0.134	
		[-1.07]	[-0.16]	
	ΔEARNVOL	0.973	0.479	
		[0.48]	[0.78]	
Financing	ΔLEVERAGE	-0.002	0.939*	
		[-0.00]	[1.73]	
	STOCK_ISS	-0.159	0.377	
		[-0.62]	[1.60]	
Observations		8,010	7,932	
Adjusted R-squared		3.0%	2.6%	

*** p < 0.01, ** p < 0.05, * p < 0.1

TABLE 9
Decision to Provide Earnings Guidance

This table examines how performance influences the likelihood that a firm that invests in R&D will provide earnings guidance in the coming year. The estimates are obtained using both logistic and OLS regression models. The dependent variable is coded as 1 if the firm issues guidance and zero otherwise. All other variables are defined as in Table 4.

	Variable	Logit Estimation	OLS Estimation
	Intercept	-4.067***	-0.317***
		[-14.10]	[-5.46]
Performance	adjROA	1.682***	0.142***
		[7.50]	[5.36]
Information Environment	SIZE	0.394***	0.115***
		[12.06]	[10.68]
	ANALYSTS	0.018**	0.009***
		[2.21]	[4.77]
	%INST	1.238***	0.112***
		[7.97]	[3.30]
Investment Type	R&D/OPX	-1.693***	-0.117***
		[-5.68]	[-2.60]
	BM	-0.138*	-0.060***
		[-1.70]	[-5.17]
	CAPINT	-0.240	0.041
		[-0.92]	[0.79]
Uncertainty	RETVOL	0.382	-0.003
		[1.13]	[-0.08]
	EARNVOL	0.384***	0.011
		[3.18]	[0.47]
Financing	LEVERAGE	-0.544***	-0.092***
		[-3.36]	[-3.47]
	STOCK_ISS	0.179***	-0.003
		[3.08]	[-0.37]
Fixed Effects		Industry and Year	Firm and Year
Standard Error Clustering		Firm and Year	Firm
Observations		18,132	18,144
Pseudo (Adjusted) R-squared		23.3%	58.2%

*** p < 0.01, ** p < 0.05, * p < 0.1

TABLE 10
Information Content of 10-K R&D Disclosures

Panel A examines the relation between levels and changes in R&D disclosure and the absolute market-adjusted stock return to the 10-K filing in the window [-1, +1] centered on the 10-K filing date. Panel examines the relation between R&D disclosure and the signed market-adjusted 10-K return. Δ10-K Length is the year-over-year in the total number of sentences in a firm's 10-K filing. EA_{Return} is the 3-day market adjusted return centered on the firm's earnings announcement. MC is the firm's market capitalization and MB is the firm's market-to-book ratio at the end of the fiscal year. All other variables are defined as in Table 5. t-statistics (in brackets) are based on standard errors that are clustered on firm and time.

Absolute 10-K Event Returns

Variable	(1)	(2)	(3)	(4)
Intercept	0.0118***	-0.0129	0.0163***	0.0164***
	[7.41]	[-1.47]	[14.49]	[14.83]
Ln($R\&D_{DISC}$)	0.0054***	0.0047***		
	[5.01]	[4.72]		
Ln(10-K Length)		0.0045***		
		[3.18]		
abs($\Delta R\&D_{DISC}$)			0.0004***	0.0003***
			[4.42]	[4.26]
abs(Δ10-K Length)				0.0000
				[0.95]
abs(EA_{Return})	0.0742***	0.0736***	0.0780***	0.0780***
	[5.51]	[5.56]	[5.64]	[5.65]
abs(adjROA)	0.0060	0.0070	0.0050	0.0050
	[0.70]	[0.83]	[0.58]	[0.59]
abs(ΔadjROA)	0.0405***	0.0383***	0.0451***	0.0449***
	[6.25]	[6.24]	[6.42]	[6.44]
Log(MC)	-0.0047***	-0.0051***	-0.0048***	-0.0048***
	[-12.55]	[-16.04]	[-12.56]	[-13.19]
Log(B/M)	-0.0019	-0.0022	-0.0027	-0.0028
	[-0.81]	[-0.93]	[-1.11]	[-1.12]
Observations	16,351	16,351	16,351	16,351
Adjusted R-squared	16.4%	16.6%	15.8%	15.8%

*** p<0.01, ** p<0.05, * p<0.1

TABLE 11

10-K R&D Disclosures and Relative Bid-Ask Spreads

Panel A examines the relation between R&D disclosure and the average level of firms' relative bid-ask spread following the 10-K filings (+2, +5). Panel B examines the relation between changes in R&D disclosure and the changes in the level of firms' relative bid-ask spread caluclatd as the difference between the average relative spread in event window (+2, +5) less the average relative spread in event window (-49, -5). 10-K Length is the total number of sentences in a firm's 10-K filing. MC is the firm's market capitalization and MB is the firm's market-to-book ratio at the end of the fiscal year. 10-K timeliness is the number of days that provides its 10-K filing prior to the statuatory deadline following Choudhary, Merkley, and Schloetzer (2011). t-statistics (in brackets) are based on standard errors that are clustered on firm and time.

Panel A. Level of Relative Bid-Ask Spread

Variables	(1)	(2)
Intercept	0.0834***	0.1236***
	[60.63]	[11.07]
ln($R\&D_{DISC}$)	-0.0046***	-0.0061***
	[-3.69]	[-4.54]
adjROA		-0.0186***
		[-2.70]
ln(MC)		-0.0149***
		[-5.73]
ln(MB)		-0.0013
		[-1.10]
Ln(10-K Length)		0.0000
		[1.61]
10-K Timeliness		-0.0002
		[-1.24]
Observations	13,012	13,012
Adjusted R-squared	4.8%	26.2%

*** p<0.01, ** p<0.05, * p<0.1

TABLE 11
(CONTINUED)
10-K R&D Disclosures and Relative Bid-Ask Spreads

Panel B. Changes in Relative Bid-Ask Spreads

Variables	(1)	(2)
Intercept	-0.0224***	-0.0074
	[-318.14]	[-0.84]
$\Delta R\&D_{DISC}$	-0.0001**	-0.0001**
	[-2.42]	[-2.52]
ΔadjROA		-0.0048
		[-1.27]
10-K Return		-0.0312***
		[-4.33]
Δ10-K Length		0.0000
		[1.32]
Δ10-K Timeliness		-0.0001*
		[-1.74]
Observations	13,418	13,418
Adjusted R-squared	0.4%	1.0%

*** p<0.01, ** p<0.05, * p<0.1

APPENDICES

APPENDIX A
R&D-Related Disclosure Key Words

This appendix provides the list of R&D-related keywords and phrases used to classify a sentence as an R&D-related disclosure. I developed the list through a careful review of over one hundred and fifty 10-K filings of firms included in my sample. To ensure that my keywords list is reasonable I consulted industry personnel on R&D-related disclosure topics and compared my list with examples used in Entwistle (1999) and James and Shaver (2009). In addition, the results of this study are similar when R&D-related disclosure is calculated using only the bolded key words.

research and development
R&D
product development
research, development
research, engineering, and development
research and product development
research development
research project
research and evaluation project
research program
research collaboration
research facility
research facilities
research initiative
research venture
research center
conduct research
new technology
joint research
develop technology
entering development
developing new products
development of new products
research operations
research pipeline
product engineering
technology development
technical development
technology milestone
technology breakthrough
technological breakthrough
breakthrough innovation
clinical candidate
product candidate
drug candidate
breakthrough in
developing new technologies
development of proprietary technology
established a collaboration
projects in development
completion of key milestones
continuing development of
preclinical development
preclinical data
evaluating the potential of
clinical data
clinical development
clinical program
clinical study
safety study
pilot study
announced a collaboration
joint venture to develop
collaborative initiative
research collaboration
collaborative research
research collaborative
new patent
applied for patent
claims in this patent
filed patent
granted a patent
issued a patent
new patent
received a patent
patent was awarded
key patent
important patent
patents pending
applications pending

APPENDIX B:
Examples of R&D-Related Subject Disclosure

R&D Progress	We have initiated a clinical development plan which we believe will allow us to begin global Phase3 clinical studies in Alzheimers disease in 2008 and, if those studies are positive, to apply for U.S. and European marketing approval for Alzheimers disease in 2010. However, we caution you that these are forward-looking statements, and as such are subject to significant risk and uncertainty.
R&D Collaboration	In February 1999, we entered into a four-antibody corporate collaboration with MedImmune. The agreement covers the licensing of Vitaxin to MedImmune as well as the optimization of three additional antibodies, including Synagis and an antibody against IL-9. Licenses granted under this agreement are exclusive and worldwide covering the right to research, develop, sell and sublicense. The business terms of the agreement includes research and development support, potential milestone payments, royalties on the sales of products resulting from the collaboration and an equity investment. The duration of the research and development aspect of this agreement has been extended through February 2003.
R&D Competition	The Company intends to make further investments in people and equipment in subsequent years in order to increase new product development. The semiconductor industry is highly competitive and the Company expects competitive pressures to continue. The Company is in direct and active competition, as to one or more of its product families, with at least thirty manufacturers of such products, of varying financial size and strength.
R&D Strategy	This strategy is designed to align our product development initiatives with our manufacturing processes and manufacturing cost structure, and to reduce our exposure to more commodity-type product applications that are prone to unpredictable demand and fluctuating pricing. Our focus is primarily on higher-margin products that possess design features that take optimal advantage of our existing and developing manufacturing technology and that command a price commensurate with the performance advantages of our alloys. In addition to our focus on products with higher

	gross margins, we will continue to engage in prototype manufacturing, both for internally manufactured products and for products that will ultimately be licensed to or manufactured by third parties.
Patents	As of December 31, 2007, we had 95 granted patents in the United States from 58 families as well as 75 patent families with pending patent applications. We intend to file additional patent applications when appropriate, and to aggressively prosecute, enforce, and defend our patents and other proprietary technology.
R&D Funding	In August 2003, we signed a new $3.0 million research and development contract with the U.S. Army for the development of KEPs, which was later supplemented by additional $2.7 million. Our strategy is to orient the KEP program toward future systems such as the Joint Strike Fighter program and the Armys Future Combat System. We also continue to work with a number of defense-related research and development agencies and large defense companies to identify additional military applications that may benefit from using Liquidmetal alloys.
R&D to Operations	Our losses have resulted principally from expenses incurred in research and development of our technology and products and from selling, general and administrative expenses that we have incurred while building our business infrastructure. We expect to continue to incur significant operating losses in the future as we continue our research and development efforts and seek to obtain regulatory approval of our products. Our ability to achieve profitability depends on our ability to raise additional capital, complete development of our products, obtain regulatory approvals and market our products.
R&D Facilities	The Company's business units maintain product development and engineering departments whose activities are focused on improving existing products and services and developing new technologies to meet customer demands for improved drilling performance and environmental-based solutions for drilling and completion operations. The Company's primary research facilities are located in Houston, Texas; Stavanger, Norway; and Aberdeen, Scotland. The Company also maintains a drill bit database which records the performance of substantially all drill bits used in the United States over the last 16 years, including

	those manufactured by competitors.
R&D to Prior Periods	Research and development expenses in fiscal 2004 decreased $0.7 million to $14.6 million from $15.3 million in fiscal 2003 due to our reduced silicon development efforts in 2004. Research and development expenses in fiscal 2003 decreased $0.1 million to $15.3 million from $15.4 million. In fiscal 2002 research and development expenditures were constant due to managements dedication to the development of new and enhanced products, such as the next generation quartz automotive gyro sensor, NCAPS torque sensors and improvements to other existing product families.
Regulation	Governmental and regulatory authorities may approve a product candidate for fewer indications or narrower circumstances than requested or may condition approval on the performance of post-marketing studies for a product candidate. Even if a product receives regulatory approval and clearance, it may later exhibit adverse side effects that limit or prevent its widespread use or that force us to withdraw the product from the market. Any marketed product and its manufacturer will continue to be subject to strict regulation after approval.
R&D Employees	The Company employs approximately 18 people in its research and development department, including seven PhDs with specialties in the fields of molecular biology, protein chemistry, vascular physiology, and biochemistry.
R&D Tax Credit	We also have research and development tax credit carry forwards of approximately $1.9 million that begin to expire in 2005, if not previously utilized. Utilization of our net operating loss carry forwards will be subject to limitations due to the change in ownership provisions of the Internal Revenue Code of 1996, as amended, as a result of our prior issuances of equity securities. These carry forwards, therefore, may expire prior to being fully utilized.
In-process R&D	The acquired in-process research and development projects are in various stages of development, had not reached technological feasibility at the time of acquisition and had no known alternative uses. The efforts required to develop the acquired in-process research and development into commercially viable products

	include completion of the development stages of the commercially viable products, clinical-trial testing, FDA approval and commercialization. Due to the nature of the pharmaceutical development process, the Company anticipates incurring additional costs to develop these products.
R&D Market	In response to this rapidly growing market, handset original equipment manufacturers, or OEMs, are significantly shortening product development cycles, seeking simplified architectures and streamlining manufacturing processes. Traditional OEMs are shifting to low-cost suppliers around the world. In turn, original design manufacturers, or ODMs, and contract manufacturers, who lack RF and systems-level expertise, are entering the high-volume mobile phone market to support OEMs as well as to develop handset platforms of their own.
R&D to Sales	Net product development expenses as a percentage of revenues were 4.3%, 8.6% and 8.0% in 1996, 1995 and 1994, respectively.

APPENDIX C:
Additional Results Using R&D Press Release Counts

This appendix provides additional results on the relation between current performance and R&D disclosure using R&D-related press releases as a measure of disclosure. In the first two columns the dependent variable is natural logarithm of the number of R&D related press releases issues during the fiscal year and the analysis is conducted using ordinary least squares regression. In the second two columns the analysis is conducted based on a logit model and the dependent variable is coded 1 if the firm issued at least one R&D-related press release and is zero otherwise. An article is identified as an R&D-related press release if it contains the bolded words from Appendix A. The analysis is conducted on a subsample of firms with high levels of R&D expenditures relative to sales and operating expenses. All results include industry fixed effects.

	Variable	**Log(1+#R&DNEWS)**		**R&DNEWS > 0**	
	Intercept	-0.9817***	-0.9107***	-2.3031**	-2.1911**
		[-6.07]	[-5.41]	[-2.29]	[-2.14]
Performance	adjROA	-0.2488*		-0.5044**	
		[-1.67]		[-2.10]	
	$R\&D_{PAYOFF}$		-0.0218		-0.0355
			[-1.24]		[-1.04]
Information Environment	SIZE	0.1713***	0.1715***	0.2847***	0.2847***
		[8.22]	[8.24]	[7.72]	[7.75]
	ANALYSTS	0.0117**	0.0112**	0.0152*	0.0142*
		[2.20]	[2.04]	[1.85]	[1.74]
	%INST	-0.1332	-0.1428	0.0699	0.0502
		[-1.20]	[-1.30]	[0.44]	[0.32]
	MFCOUNT	0.0211*	0.0206*	0.0346**	0.0336**
		[1.80]	[1.74]	[2.55]	[2.47]
Investment Type	R&D/OPX	0.8048***	0.7757***	2.0511***	1.9774***
		[5.15]	[5.15]	[4.66]	[4.55]
	MB	0.0097***	0.0086***	0.0140*	0.0116
		[3.37]	[2.91]	[1.96]	[1.64]
	CAPINT	-0.0073	-0.0237	-0.1323	-0.1635
		[-0.05]	[-0.16]	[-0.49]	[-0.61]
Uncertainty	RETVOL	-0.1086	-0.0218	0.3201	0.4749
		[-0.62]	[-0.12]	[1.07]	[1.58]
	EARNVOL	0.0246	0.0831	0.0402	0.1657
		[0.32]	[0.91]	[0.18]	[0.76]
Financing	LEVERAGE	-0.3134***	-0.2715**	-0.7167***	-0.6309**
		[-2.62]	[-2.38]	[-2.73]	[-2.43]
	STOCK_ISS	-0.0220	-0.0212	0.0118	0.0127
		[-0.79]	[-0.76]	[0.19]	[0.20]
Standard Error Clustering		Firm and Year	Firm and Year	Firm	Firm
Observations		7,032	7,032	7,022	7,022
Adjusted (Pseudo) R-squared		23.9%	23.8%	9.7%	9.7%

*** p < 0.01, ** p < 0.05, * p < 0.1

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