Is R&D Mispriced or Properly Risk-Adjusted?

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Abstract

Research has established that R&D-intensive firms are characterized by substantial future risk-adjusted stock returns. The reasons for this phenomenon and its policy implications, however, are widely debated. Some attribute the excess returns to investors' systematic undervaluation of R&D firms and argue for improved disclosure to mitigate the mispricing, while others claim that the excess returns are just compensating for an R&D-specific risk factor and, therefore, no accounting changes are called for.

We aim at providing insights into this controversy by examining R&D firms with substantial R&D outlays, i.e., firms with R&D as an important ingredient in their strategy. Among such firms we compare firms with high and low industry-adjusted R&D intensity. The high industry-adjusted R&D intensity firms are more likely to be engaged in basic research activities, while the low industry-adjusted R&D intensity firms are likely to mimic and extend existing technologies. As such, compared to the low industry-adjusted R&D intensity firms, the high industry-adjusted R&D intensity firms are likely to suffer from higher information asymmetry. We find that high industry-adjusted R&D intensity firms exhibit substantially positive risk-adjusted returns during the first four-five future years, after which these excess returns converge to those of low industry-adjusted R&D intensity firms. This evidence is consistent with a significant *undervaluation* of high industry-adjusted R&D intensity firms. The long-term excess returns are positive for both the high and the low industry-adjusted R&D intensity firms and these excess returns are partly attributable to information risk. We also show that the future excess returns of high industry-adjusted R&D intensity firms are substantially lower for those firms who provide voluntary disclosure (earnings guidance) suggesting that the short-term undervaluation is likely due to mispricing.

I. Introduction

We examine whether the widely-documented positive association of R&D spending with future excess stock returns is due to investors' mispricing or to researchers' inadequate adjustment for risk, and in the case of the latter, whether the future excess returns are attributed to information risk, in which case there are important policy implications to draw. Lev and Sougiannis (1996), Chan et al. (2001), Eberhart et al. (2004), Lev et al. (2005), and Lev et al. (2007), among others, document that R&D outlays and their changes are positively associated with future excess returns, suggesting that investors underreact to R&D outlays and that this underreaction is partly attributable to the conservative accounting treatment of R&D spending. In contrast, Chambers et al. (2002) argue that R&D's future excess returns are positive over the long-term (ten years), suggesting that these returns are primarily attributable to risk. The R&D risk-or-mispricing controversy has important implications for the state of capital market efficiency, for practicable portfolio management (mispricing can be exploited by arbitrage), and particularly for accounting standard-setting. For example, Skinner, in an opinion piece (2008), rejects calls for increased disclosure about intangible investments and R&D by claiming that the subsequent excess returns to R&D are attributable to inadequate adjustment for risk. Others beg to differ. It is, therefore, of considerable importance to provide insights into the risk-or-mispricing question of R&D.

While prior studies argue that mispricing or delayed reaction by investors to R&D outlays is likely due to inadequate information on cash flows or biased assessment of R&D prospects by investors (the numerator effect of stock valuation), there are no studies investigating potential reasons for a higher risk of R&D firms (the denominator effect of valuation). The literature on cost of capital or systematic risk identifies two important determinants of risk:

business risk and information risk.[1] Applying this dichotomy to the "source" of R&D risk—business or information—is important because the two sources have different policy implications. If business risk is the reason investors demand a higher return for R&D firms, then fiscal incentives (R&D subsidies) are likely to mitigate R&D risk.[2] On the other hand, if information risk is the reason for investors' demand for a higher rate of return for R&D firms, then standard-setting institutions can help mitigate such information risk through improved disclosures. Thus, providing insight into the source of R&D risk is important for policy issues, as is resolving the mispricing issue.

To address both the R&D mispricing-or-risk questions, and, if risk, whether business or information risk, we examine a large sample of firms with substantial R&D outlays so as to examine firms with R&D as an important strategy. Among such firms, and in contrast with previous research on R&D which implicitly considered firms' R&D programs identical, we strive to distinguish among R&D programs, since both investors' perceptions of R&D prospects and the risk of R&D likely vary with the nature of R&D. Distinguishing among firms' R&D is seriously hampered, though, because most firms don't provide any information about the nature of R&D (e.g., how much research vs. development, basic vs. applied R&D, or the stage of product development) beyond the total periodic outlays. We use the industry-adjusted R&D intensity to distinguish between the nature of R&D activities. While the measure is based on R&D intensity, adjusting for industry helps to distinguish between firms that are likely engaged in basic versus applied research. For instance, the R&D intensity of generic drug manufacturers' in the pharmaceutical industry is higher than the R&D intensity of firms that engage in basic

[1] See Beaver et al. (1970) and Kothari et al. (2002) for arguments that business risk likely affects the valuation of R&D firms. Easley and O'Hara (2004), Lambert et al. (2007), and Francis et al. (2005) show that information risk is priced as an undiversifiable risk factor.

[2] Firms also employ mechanisms such as R&D alliances and joint ventures to mitigate R&D risk.

research in the food products industry. Thus, R&D intensity by itself is not likely to discriminate among the nature of R&D. Adjusting for R&D intensity within an industry group is consistent with the arguments in the innovation and strategy literatures. Specifically, some firms use R&D as a strategic tool for innovation; these firms strategically choose to be innovators and develop new generations of products and services are likely to be the high industry-adjusted R&D intensity firms. The low industry-adjusted R&D intensity firms mimic the products or services of innovation high industry-adjusted R&D intensity firms and are low cost providers (see Porter (1980)). Thus, within their industry high innovation firms are likely to have substantially higher R&D levels than low innovation firms and their R&D is likely to be riskier (more research than development) than low industry-adjusted R&D intensity firms' R&D.

We define the first five years after a firm is classified as high or low industry-adjusted R&D within their industry as the short-term and the next five years as the long-term. We find that high industry-adjusted R&D intensity firms' average short-term excess returns is roughly five percent greater than that of low industry-adjusted R&D intensity firms. The long-term excess returns of both high and low industry-adjusted R&D intensity firms are identical at roughly 2.50% percent annually. This pattern of convergence of the excess returns of high industry-adjusted R&D intensity firms from 5% in the first five years to 2.50% subsequently, indicates mispricing. This return reversal of high industry-adjusted R&D intensity firms is documented here for the first time.

We then examine the association between short-term and long-term R&D excess returns and business and information risk proxies, controlling for other factors of risk examined in earlier studies. We measure business risk by the standard deviation of future earnings and the standard deviation of future cash flows, and information risk by the absolute value of analyst' earnings forecast errors, the dispersion of analysts' earnings forecasts, following Leuz (2003), Heflin et al. (2003), and Bowen et al. (2002) as well as accruals quality, following Dechow and Dichev (2002). We find that both business risk and information risk are positively associated with both the short- and long-term excess returns, suggesting that the proxies of risk capture additional priced risk factors. In addition, we find that high industry-adjusted R&D intensity firms have roughly 2% greater short-term excess returns than low industry-adjusted R&D intensity firms after controlling for business and information risk, indicating that this return is likely attributable to mispricing. We also find that both high and low industry-adjusted R&D intensity firms have no long-run excess returns after controlling for the proxies of business and information risks. This indicates that the long-run excess returns are in part attributable to information risk.

Finally, under the maintained assumption that firms that provide more earnings guidance are also likely to provide more information to investors (see Jones, 2007), for a sub-sample of firms with earnings guidance, we find that the short-term excess returns are substantially lower for high industry-adjusted R&D intensity firms who provide more earnings guidance than for high industry-adjusted R&D intensity firms who provide less guidance. This evidence suggests that information asymmetry likely drives the short-term mispricing, and improved disclosure can mitigate it.

The rest of the paper is organized as follows: Section II presents underlying rationale for categorizing firms as high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms, while Section III discusses the sample and the characteristics of high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms. Section

IV provides the main empirical analysis; and Section V provides evidence of mispricing mitigation by disclosure, and section VI concludes the paper.

II. Background on nature of R&D activities

This section discusses the importance of considering the nature of R&D activities. The strategy literature suggests that based on core competence, competition and market structure, firms strategically choose to be innovators by developing new generations of products, or services, while other firms strategically choose to mimic the innovators and make the new generation technology available to the masses (see Porter (1980)).[3] As such, the nature of R&D is likely to be substantially different for the innovators and mimicking firms. For example, innovators will invest heavily in basic research in the development of new technologies, whereas mimickers such as generic drug companies mainly focus on modifying current technologies. Basic research is both more costly and risky than "development" (modifying available technologies). It stands to reason that the riskier basic research is more obscure from investors than research on existing technology, and therefore will be associated with larger future excess returns (mispricing)—our focus of analysis.

As a first step in distinguishing the different nature of R&D across firms, we use the industry-adjusted R&D capital- to-sales ratio to classify high and low industry-adjusted R&D intensity firms.[4] There are two reasons for using an industry benchmark: First, the industry-

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[3] R&D programs reflecting innovation strategy can be classified on three-dimensions: the type of innovation that a firm seeks to develop (product or process, see Cohen et al. (2000)), the nature/type of R&D activity (basic and applied research activity or mainly development activity, see Griliches (1986) and Nelson and Romer (1996)), and the coalitions and collaborations with other firms (outward- or inward-oriented strategy, see Baumol (2002)). There is no requirement for firms to disclose this information and firms rarely voluntary disclose such information (Lev, 2001).

[4] While data on patents is available and can be considered as a proxy for high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms, Griliches (1986) provides reasons for why counting patents is not adequate to distinguish between high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms. Research that examines why firms patent only some innovations shows that (a) firms patent

adjusted R&D intensity controls for the competitive forces in the industry. For instance, even a low industry-adjusted R&D intensity in the pharmaceutical industry will have a higher R&D intensity than that of a high industry-adjusted R&D intensity in the food products industry. Using the industry benchmark controls for the inter-industry differences in R&D intensity. Second, Inklaar et al. (2004) state that items included in research and development spending vary widely across industries. For instance, engineering firms include quality control costs in R&D expenditures, while pharmaceutical firms do not include such costs. On the other hand, pharmaceutical firms classify after market studies as R&D expenditures. Using the industry benchmark controls for the differences across industries in the definition of R&D items.

Before proceeding with the stock market valuation of high and low industry-adjusted R&D intensity firms, we validate in the next section that our classification of R&D firms to high and low industry-adjusted R&D intensity firms captures fundamental attributes of risk and returns of R&D firms.[5]

III. Characteristics of high and low industry-adjusted R&D intensity

We consider all firms with positive R&D expenditures from 1975 through 1997, having financial information in the Compustat annual database.[6] We delete firms with either sales less than $10 million or total assets less than $5 million to exclude negligible firms. We obtain data

innovations when infringement is easier to detect and prove, and (b) firms do not patent innovations that are difficult to imitate (see Arundel and Kabla (1998), Brouwer and Klienknecht (1999)).

[5] Our measure of high and low industry-adjusted R&D is similar in spirit to R&D leaders and followers alluded to in the strategy and economics literature. In general, this stream of literature shows that R&D leaders have higher profitability than R&D followers. Caves and Ghemawat (1992) use a small sample of firms and show that innovators have higher profits than low industry-adjusted R&D intensity firms. Also see Caves and Porter (1977), Gruber (1992), Klette (1996) and Cardinal and Opler (1995). Consistent with these findings, in unreported analysis, we find that high industry-adjusted R&D intensity firms have higher future profitability as measured by return on assets and return on equity than low industry-adjusted R&D intensity firms. Also, the strategy literature emphasizes that firms self-select to either being a leader or a follower, based on their core-competence/capabilities. We assume that firms make this choice in an appropriate fashion. We do not explicitly control for such self-selection in our research design, because we wish to examine the risk and return profiles of these groups.

[6] The sample period extends up until 1997 because we examine long-term returns (six- to ten-years ahead returns). Thus, for the returns we use data up until 2006. We check the robustness of our results by extending the sample to 2002 and find similar results.

on R&D expenditures (Compustat data item # 46) and sales (Compustat data item # 12) from the Compustat annual database, and data on stock prices and number of shares outstanding from the CRSP database. We obtain analysts' earnings forecasts and forecast dispersion from IBES Summary Files, and require that firms are followed by at least two analysts so that the measure of forecast dispersion is a meaningful proxy of information risk.

Following Chambers et al. (2002), we use the R&D capital-to-sales ratio to indicate R&D intensity. The benchmark R&D intensity of the industry is the weighted average R&D capital–to–sales of all firms in the industry group, where the weights are sales. For the industry groups, we use the 48 industries in Fama and French (1997).[7] We use the weighted industry average to minimize the influence of small firms spending a large proportion of their revenues on R&D and skewing the classification.[8] Firms whose R&D intensity is greater than the benchmark R&D intensity for the industry are classified as high industry-adjusted R&D intensity firms, and the rest as low industry-adjusted R&D intensity firms.

Table 1, Panel A provides several characteristics of high and low industry-adjusted R&D intensity firms. Out of the annual average of 399 firms, 253 firms or 63% are classified as high industry-adjusted R&D intensity firms. There are fewer low industry-adjusted R&D intensity firms than high industry-adjusted R&D intensity firms because we consider only the top three quintiles of R&D capital-to-sales firms, to eliminate from the sample firms with negligible R&D activities and we use value-weighted industry benchmark. Panel B of Table 1 provides evidence on the persistence of the high and low groups: 59.49% (51.62%) of high (low) industry-adjusted R&D intensity firms continue to be high (low) industry-adjusted R&D intensity firms after the fifth year following classification, indicating that the classification is a long-term strategic choice

[7]The mapping is obtained from Ken French's website http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html .

[8] When we use equally-weighted industry average we obtain similar results.

by the firm. After five years, low R&D intensity firms are more likely to become high R&D intensity firms than vice versa.

Both high and low industry-adjusted R&D intensity firms exhibit similar survival rates: 28.58% (26.03%) of high (low) industry-adjusted R&D intensity firms leave our sample after five years. Panel C of Table 1 provides the reasons for firms not in our sample after five years. For this purpose, we use the delisting codes as in Shumway (1997). Roughly 80% of both the high and the low groups are not-in-sample after five years due to mergers and acquisitions; and, 12%-13% of the both the high and low groups are not-in-sample due to performance-based listing requirement violations. That is, firms that are not-in-sample due to poor performance is roughly 3% [=28% × 13%] for both the high and low R&D groups.

Panel D provides descriptive statistics for some firm characteristics of the high and low groups. The panel reports the mean value of annual mean, and the t-statistics are computed using the standard errors of the annual mean (see Fama and MacBeth (1973)). The mean R&D capital-to-market value for high (low) industry-adjusted R&D intensity firms is 25.18% (14.64%), suggesting that low industry-adjusted R&D intensity firms are considerably less R&D-intensive than high industry-adjusted R&D intensity firms. The book-to-market ratio and dividend yields of the high group are lower than that of low group, however, only the difference in book-to-market is marginally significant. The mean sales growth is higher for the high than the low group. In addition, the market share for high group is marginally greater than that for low group. The high industry-adjusted R&D intensity firms are larger companies, as indicated by the mean book value of equity, total assets and sales. However, they are more profitable, as indicated by the return-on-assets, (return on asset is computed using operating income before R&D spending to focus on operational difference across high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms). All descriptive statistics indicate the existence of fundamental operating differences between high and low industry-adjusted R&D intensity firms.

Kothari et al. (2002) find that R&D expenditure is more strongly associated with the standard deviation of future earnings than capital expenditures. This suggests that R&D expenditures increase business risk. Our research objective is to examine whether systematic differences in the relationship between R&D and business risk exist for high and low industry-adjusted R&D intensity firms. We thus augment the Kothari et al. (2002) model and estimate the following equation:

$$SD_{i,t} = [\text{Industry Fixed Effects}] + \beta_{1t}\, IRDH_{i,t} + \beta_{2t}\, R\&DM_{i,t} + \beta_{12t}\, IRDH_{i,t} * R\&DM_{i,t} + \beta_{3t}\, CapEx_{i,t} + \beta_{4t}\, LMV_{i,t} + \beta_{5t} LEV_{i,t} + error_t, \quad (1)$$

where SD is the standard deviation of earnings-per-share before extraordinary items and discontinued operations (Compustat data item # 58), and alternatively, the standard deviation of cash flow from operations (Compustat data item # 308).[9] The standard deviation is calculated using five annual earnings/cash flow observations for years t+1 through t+5, and each earnings observation is deflated by the stock price, P, at the beginning of the period t.[10] The indicator variable IRDH is one if a firm has a positive (zero for negative) industry-adjusted R&D Capital–to–Sales in year t. The industry-adjusted R&D capital-to-sales is R&D capital-to-sales for a given firm minus the industry's sales-weighted R&D capital–to–sales. The variable R&DM is the R&D expenditure per share deflated by P.[11] CapEx is the capital expenditure per share (Compustat data item # 128) deflated by P. LMV is the natural logarithm of the market value of

[9] Cash flow from operations is based on the statement of cash flows for 1987 to 1997. For 1975-1986, similar to Givoly and Hayn (2000), cash flow from operations = fund from operations – (Δ current assets + Δ debt in current liabilities – Δ current liabilities – Δ cash).

[10] Similar to Kothari et al. (2002) when earnings or cash flow data are missing for any year t+1 through t+5, the standard deviation is set equal to the mean of SD for the firms in the same Altman Z-Score decile portfolio in year t.

[11] While our test variable is based on R&D Capital to Sales, we use R&DM for the R&D exposure so as to be consistent with Kothari et al. (2002). The coefficient estimate on R&DM is qualitatively similar to that obtained by Kothari et al. (2002). In unreported analysis using R&D Capital to Sales instead of R&DM the R&D Capital to Sales is not statistically significant, but IRDH and its interaction with R&D Capital to sales are qualitatively similar.

equity in April. LEV is the ratio of book value of debt (Compustat data item # 9 plus Compustat data item # 34) to the market value of equity plus debt.

The coefficient estimate, β_1 in equation (1) captures the abnormal standard deviation of future earnings/cash flows for the high industry-adjusted R&D intensity firms compared to the low industry-adjusted R&D intensity firms, and the coefficient estimate, β_{12} captures the additional standard deviation of high industry-adjusted R&D intensity firms' earnings and cash flows compared to that of low industry-adjusted R&D intensity firms for a dollar of R&D, after controlling for other factors, such as size, financial and operating leverage, and industry effects.

Table 2, Panel A provides descriptive statistics of the variables used to estimate equation (1). The average standard deviation of earnings (cash flows) for the high group is greater (lesser) than that of the low group: the mean standard deviation of earnings (cash flows) of high and low industry-adjusted R&D intensity firms are 0.0319 and 0.0321 (0.0293 and 0.0345), respectively. However, only the difference in standard deviation of earnings is marginally significant. While the marginally higher variability of the high group is consistent with Kothari et al. (2002), we note that the low group have significantly higher capital expenditures and larger financial leverage than the high group, and these variables are positively associated with the variability of earnings (see Kothari et al. (2002)). The higher capital expenditure for the low group is consistent with the notion that firms choose their strategy appropriately: firms with intangible core competency such as research and development are likely to use less of the brick and mortar, tangible assets. The higher capital expenditure is consistent with higher financial leverage for the low group, as well as the notion that intangible assets are not financed through debt.[12] Most importantly, we need to control for these differences as in equation (1), before drawing conclusions on the relationship between business risk and nature of R&D.

[12] The mean LMV is negative because the market value of equity is in billions of dollars (see Kothari et al., 2002).

Table 2, Panel B provides the results of estimating equation (1). We find that the standard deviation of the high group is *lower* than that of the low group for a dollar of R&D: β_{12} = -0.0388, when the dependent variable is the standard deviation of earnings, and β_{12} = -0.0623 when the dependent variable is the standard deviation of cash flow from operations. These differences are statistically significant, and indicate that high industry-adjusted R&D intensity firms have lower business risk than low industry-adjusted R&D intensity firms for a dollar of R&D spending.[13]

This *counterintuitive* finding is explained in the economics and strategy literature which argues that innovators typically engage in multiple research projects (see Szwejczewski et al. (2006), Eilat (2006)), which provide them with a greater opportunity to diversify the business risk across these projects. Innovators are also likely to diversify the higher business risk of individual research projects through joint ventures, alliances and consortiums (Naomi, 1989). Furthermore, innovators not only engage in their own development activity but also license their innovation and earn revenues (see Lev (2001)). This enables them to mitigate their risk exposure even if a research project does not result in commercial development on their own. Also, the barrier to entry created through innovation decreases dissolution risk (Banbury and Mitchell (1995)). Thus, our finding is consistent with the notion that innovators, i.e., high industry-adjusted R&D intensity firms are likely to mitigate the risk of research projects by (a) holding more diversified research portfolios, (b) having additional options with successful research, (c)

[13] We estimate equation (1) without the interaction between high industry-adjusted R&D intensity with R&DM and find that the main effect, industry-adjusted R&D intensity is negative and significant, indicating that controlling for other factors high industry-adjusted R&D intensity firms have a lower business risk than low industry-adjusted R&D intensity firms. In unreported analysis we also find that both the high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms have lower standard deviation of earnings and cash flows than the first two quintiles of R&D firms.

diversifying more risky research thorough joint ventures and alliances, and (d) reducing dissolution risk due to barriers to entry.

Moving to information risk, we use the absolute value of analysts' earnings forecast errors and analysts' earnings forecast dispersion as proxies for information risk or its inverse—information quality. Prior studies suggest that dispersion of analysts' forecasts reflects information quality and the quality of the firms' disclosures (Lang and Lundholm (1996), Krishnaswami and Subramaniam (1998), Luez (2003)). Similarly, Heflin et al. (2003) use analysts' forecast errors and dispersion of analysts' forecast to examine the impact of Regulation Fair Disclosure on the quality of information available to investors. In addition, we use the accruals quality measure developed Dechow and Dichev (2002) as another proxy of information risk. Francis et al. (2005) show that information risk as measured by accruals quality is a priced-in risk factor. We augment Lang and Lundhom's (1996) model and estimate the following equation.

$$IR_{i,t+1} = [\text{Industry Fixed Effects}] + \beta_{1t}\, IRDH_{i,t} + \beta_{2t}\, R\&DM_{i,t} + \beta_{12t}\, IRDH_{i,t} * R\&DM_{i,t} + \beta_{3t}\, STDROE_{i,t} + \beta_{4t}\, LMV_{i,t} + \beta_{5t} CORR_{i,t} + \beta_{6t} ACHEPS_{i,t} + \beta_{7t}\, ROA_{i,t} + \beta_{8t}\, PROA_{i,t} + error_t, \quad (2)$$

where $IR_{i,\ t+1}$ = {$A\_ERROR_{i,\ t+1}$, $DISP_{i,\ t+1}$, WCAQ}. A_ERROR is analysts' forecast error computed as the absolute value of the difference between actual earnings and median analysts' forecast scaled by the absolute value of the median analysts' forecast. DISP is the standard deviation of analysts' earnings forecasts scaled by the absolute value of the median analysts' earnings forecast. Analyst forecast error and dispersion are measured in May following the fiscal year and forecasts are obtained from IBES Summary Files. WCAQ is accrual quality computed as the standard deviation of firm-specific residuals from the annual regression of working capital accruals on cash flows in years t-1, t and t+1 for each industry group using data from year t to year t-4 (see Francis et al. (2005), Dechow and Dichev (2002)). We use Fama and French (1997)

48 digit industry definitions in the estimation. Accrual quality indicates how well accruals map into future cash flows. Francis et al. (2005) argue that to the extent the firm-specific residual is consistently higher or lower, i.e., the standard deviation of firm-specific residuals is lower, the accruals quality is better. They also find results consistent with the notion that lower accruals quality is associated with higher cost of capital, i.e., is priced-in. STDROE is the standard deviation of return on equity in the preceding five-years. Return on equity is earnings before extraordinary items (data18) divided by book value of equity (Compustat data item # 60). ACHEPS is the absolute value of change in earnings per share scaled by stock price. CORR is the Pearson correlation coefficient between annual return and return on equity computed over the preceding five years. ROA is the return on assets, computed as earnings before extraordinary items divided by total assets (Compustat data item # 6). PROA is the average of past five years earnings divided by the average of past five years total assets. All other variables are defined in equation (1).

Table 3, Panel A provides the descriptive statistics of the variables used to estimate equation (2). The one-year ahead absolute forecast error and forecast dispersion are substantially higher for the high group. However, there is not a significant difference in accrual quality across the high and low groups. The current and past performance of the high group as measured by ROA and PROA is lower than that of the low group, possibly indicating the effect of conservative accounting (R&D expensing).[14]

Table 3, Panel B provides the results of estimating equation (2). Both the absolute value of forecast error and the forecast dispersion are higher for the high group than the low group: the coefficients on IRDH (β_1) are 0.0612 and 0.0412, respectively, and both are statistically

[14] This may appear to be at odds with the discussion in Table 1, Panel C. The metric in Table 1, Panel C is the operating earnings while the metric here is the bottom line earnings.

significant. The coefficients on the interaction term (β_{12}) for absolute value of forecast error and forecast dispersion are 2.3242 and 0.3548, respectively, and both are statistically significant.[15] The results are qualitatively similar with accruals quality, WCAQ: the coefficient estimate on the interaction term (β_{12}) is 0.0928. Overall, the results are consistent with the information quality of the high group being lower than that of the low group. Our findings suggest that the information asymmetry between the firm and its investors is larger for high industry-adjusted R&D intensity firms than low industry-adjusted R&D intensity firms. This is likely to occur because it may be difficult if not impossible for investors to discern the nature and productivity of high industry-adjusted R&D intensity firms' research efforts (basic research).[16]

Overall, these tests show that among the firms with substantial R&D outlays, the high and low industry-adjusted R&D intensity firms are substantially different in their fundamental risk characteristics. In particular, compared to the low industry-adjusted R&D firms, the information (business) risk is higher (lower) for the high industry-adjusted R&D intensity firms. We now turn to the main part of our analysis—the association of future excess returns of R&D firms and risk.

IV. Excess returns of high and low industry-adjusted R&D intensity and their causes

We begin our main empirical analysis by tracking the high and low industry-adjusted R&D intensity firms' excess stock returns for ten years subsequent to classification. Following Chan et al. (2001), each firm in the sample is assigned to a companion portfolio based on size and book-to-market, to compute excess returns. For the companion portfolio, firms are grouped

[15] We also use the probability of information-based trading measure, PIN as in Easley et al. (2002). For this purpose, we obtain data on PIN from Soeren Hvidkjaer's web site for the period of 1983 to 1997.We find that the PIN measure is not different across the high and low groups, in both the univariate and multivariate analysis. Mohanram and Rajagopal (2009) show that PIN is not a priced-in risk factor, and as such may not be capturing information risk.
[16] FASB's Business Reporting Research Project's first steering committee's report shows that there was a lack of meaningful and useful disclosures about intangible assets. The link for the report: http://www.fasb.org/brrp/BRRP2.PDF

by the book-to-market ratio into five equal groups at the end of April each year, and the size breakpoints are determined by classifying the companies into five equal groups in April each year. The group representing the smallest size is further divided into two equal groups. Thus, we have five groups of book-to-market ratio and six groups of size to determine the companion portfolio. The monthly excess returns are then computed as the difference between the firm's monthly return and the companion portfolio's monthly return. The annual excess returns are obtained by compounding the monthly excess returns from May to April of next year. Also, based on Kothari et al. (2005), to avoid "passive truncations," we substitute the value-weighted market portfolio returns corresponding to the companion portfolio for non-surviving firms.[17]

Similar to Chambers et al. (2002) we track the future excess returns for ten years. We consider the first five years following the R&D intensity classification as the short-term and the second five years as the long-term.

Short-term Future Excess Returns, Business Risk and Information Risk

To examine the relation between business risk and information risk on the one hand and future excess returns on the other hand, after accounting for other known risk factors, we augment Penman and Zhang's (2002) model and estimate the following equations.

$$\begin{aligned} ARET_{i,\,t+1,\,+5} = {} & \beta_0 + \beta_1\, IRDH_{i,\,t} + \beta_2\, SD_i(EPS_{t+1,\,+5}) + \beta_3\, SD_i(CFPS_{t+1,\,+5}) + \beta_4\, AvER_{i,\,t+1,\,+5} \\ & + \beta_5\, AvDISP_{i,\,t+1,\,+5} + \beta_6\, AvWCAQ_{i,\,t+1,\,+5} + \delta_1\, AvEP_{i,\,t+1,+5} + \delta_2\, LBM_{i,\,t} + \delta_3\, LLEV_{i,\,t} \\ & + \delta_4\, LMV_{i,\,t} + \delta_5\, EP+_{i,\,t} + \delta_6\, EP\_DUM_{i,\,t} + \delta_7\, LARGE\_INC_{i,\,t} + error_{t+1,t+5} \end{aligned} \quad (3)$$

where ARET is the average short-term size and book-to-market adjusted returns over (t+1) to (t+5). $AvER_{i,t+1,+5}$ is the average absolute analysts' median forecast error from year (t+1) to (t+5), scaled by the absolute value of median forecast in (t+1). AvDISP is the average dispersion

[17] Passive truncations refer to the non-survival bias in future excess returns. Kothari et al. (2005) show that passive truncations bias future excess returns, either higher or lower depending on the size of the firm. Chambers et al. (2002) find that the average excess returns are about 3.80% over years six to ten for high R&D firms, whereas it is around 2.24% in our sample. When we drop the analyst following criteria (to be comparable to their sample), the average excess returns are about 4.39 % over year six to ten in our sample, which is quite close to long-run returns in Chambers et al. study.

of analysts' forecasts from year (t+1) to (t+5), scaled by the absolute value of median forecast in (t+1). Analyst forecast variables are all measured in May and forecasts are obtained from IBES Summary Files. AvWCAQ is average WCAQ, accrual quality from year (t+1) to (t+5). AvEP is the average earnings over the average of earnings from year (t+1) to (t+5) divided by share price at time t. EP(+) is the earnings-to-price ratio if EP is positive and zero otherwise. Earnings to price ratio is earnings before extraordinary items (data18) divided by market value of equity.[18] EP_DUM is one if the current earnings to price ratio is negative. LBM is the natural logarithm of the book-to-market ratio. Book-to-market ratio is book value of equity (Compustat data item # 60) divided by market value of equity. LMV is the natural logarithm of the market value of equity. LLEV is the natural logarithm of the ratio of book value of debt (Compustat data item # 9 plus Compustat data item # 34) to the market value of equity plus debt. LARGE_INC is an indicator variable for large R&D increases. A large R&D increase is given by an increase of 5% in the R&D to asset ratio as well as in the R&D expenditure, for firms with R&D to asset ratio of at least 5%: that is, a firm with R&D to asset ratio in year t-1 of 5% should have an R&D to asset ratio of at least 5.25% in year t to be considered a firm with large R&D increase (see Eberhart et al. (2004).

In equation (3) the standard deviation of earnings and cash flows are proxies for business risk, and the absolute value of analysts' forecast error, forecast dispersion and accrual quality are proxies for information risk. We expect the coefficients β_2 through β_6 on proxies for business and information risk to be positive. Of course, if business and information risks are captured by risk factors such as book-to-market, size, earnings-to-price and leverage, then proxies for business and information risk are not likely to be associated with future returns. However, Francis et al.'s

[18] The definition of earnings used here is different from operating income used in Table 1, and corresponds to Penman and Zhang (2002).

(2005) result shows that information risk is a priced-in risk factor over and above the other risk factors: as such, we expect that information risk is not completely accounted for by the control variables alone.[19]

Our test variable is IRDH. The intercept estimate, β_0 captures the future excess returns of low industry-adjusted R&D intensity firms, and the coefficient estimate on high industry-adjusted R&D intensity firms IRDH, β_1 captures the additional future excess returns of high industry-adjusted R&D intensity firms relative to low industry-adjusted R&D intensity firms. We expect β_0 and β_1 to be positive based on the mispricing/delayed reaction in the short-term documented by prior studies of mispricing (see Chan et al. (2001)). Of course, β_1 is expected to be zero if all of the short-term excess return is accounted for by business and information risk, as well as the other risk factors.[20]

We include AvEP as a control variable to account for a potential correlated omitted variable of contemporaneous earnings. The LARGE_INC is a control variable for shifts in research and development spending. Eberhart et al. (2004) shows that the future performance of LARGE_INC is higher than that of other firms. In our context, it is possible that a low group firm migrates to the high group (see Table 1, Panel B) because of a large increase in R&D expenditure. LARGE_INC controls for the possibility of such a correlated omitted variable driving our results. All other control variables are risk factors that have been documented to be associated with future returns (see Penman and Zhang (2002)).

[19] Core et al. (2008) use a different research design and find that accruals quality is not priced-in

[20] We do not consider the interaction between IRDH and the business and information risk proxies. The results discussed in Tables 2 and 3 indicate that the interaction between IRDH and the R&D expenditure is associated with business and information risks. Thus, including the business and information risk proxies, already accounts for the interaction effect. In unreported analysis including an interaction between IRDH and business and information risk proxies does not affect the results qualitatively. The interaction terms are not statistically significant.

Table 4, Panel A provides the descriptive statistics of the variables in equations (3) and not already presented in earlier tables. The reported numbers are the mean of the annual means and the t-statistics are computed using the standard errors of the annual mean (see Fama and MacBeth (1973)). The abnormal return for the high (low) industry-adjusted R&D intensity firms is 5.25% (2.49%): a difference of roughly 110% = [5.25 – 2.49/ 2.49]. It follows that the difference is statistically significant. The earnings to price ratio (EP+) is lower for the high group than low group, indicating that firms in the high group are growth companies. However, the differences are not significant. The high group have a higher proportion of negative earnings (EP_DUM).

Table 4, Panel B provides the results of estimating equation (3). The mean of the annual coefficient estimates are reported, and the t-statistics are computed using the standard errors of the annual mean estimates (Fama and MacBeth, 1973). The coefficient on the standard deviation on earnings, SD(EPS), is positive and significant [β_2 = 1.0234 with t=5.21] and the coefficient on forecast dispersion, AvDISP is also positive and significant [β_5 = 0.1761 with t=4.11]. Thus, both information and business risks are associated with the short-term excess returns. Given that mean SD(EPS) and AvDISP in Panel A for the high group is 0.0319 and 0.1931, the average effect of SD(EPS) and AvDISP in returns are 3.27% and 3.40%: for SD(EPS) it is calculated as (0.0319 x 1.0241) and for dispersion (0.1931 x 0.1761). Thus, on average both information and business risks are priced-in.

Controlling for information and business risks, we find that the coefficient estimate on the high group is positive and statistically significant [β_1 = 0.0234 with t=4.69]. The coefficient on the high group without controlling for business and information risks is β_1 = 0.0323 with t=5.46. Comparing the coefficients on the high group with and without the controls for business and information risk suggests that roughly 38% [=0.0323 – 0.0234/0.0234] of the high industry-adjusted R&D intensity firms' short-term excess returns is attributable to business and information risk. Importantly, this indicates that after controlling for information and business risks, high industry-adjusted R&D intensity firms continue to earn excess returns in the short-term, which is indicative of mispricing: The intercept estimate in Panel B is negative and significant [β_1 = -0.0201 with t=-2.58] after controlling for business and information risk.

Leverage, book-to-market and size are not significant, most likely because the excess returns (dependent variable) are already book-to-market and size adjusted. Earnings-to-price ratio is marginally significant, indicating that the book-to-market and size adjusted returns do not completely account for the risk factor captured by the earnings-to-price ratio. The LARGE_INC dummy is significant suggesting that after controlling for R&D intensity, R&D growth is positively associated with returns.

Long-term Future Excess Returns, Business Risk and Information Risk

Similar to equation (3) we consider the long-term returns by estimating the following equation.

$$\begin{aligned} ARET_{i,\,t+6,\,+10} &= \beta_0 + \beta_1\, IRDH_{i,\,t} + \beta_2\, SD_i(EPS_{t+6,\,+10}) + \beta_3\, SD_i(CFPS_{t+6,\,+10}) + \beta_4\, AvER_{i,\,t+6,\,+5} \\ &+ \beta_5\, AvDISP_{i,\,t+6,\,+5} + \beta_6\, AvWCAQ_{i,\,t+1,+5} + \delta_1\, AvEP_{i,\,t+6,+10} + \delta_2\, LBM_{i,\,t} + \delta_3\, LLEV_{i,\,t} \\ &+ \delta_4\, LMV_{i,\,t} + \delta_5\, EP+_{i,\,t} + \delta_6\, EP\_DUM_{i,\,t} + \delta_7\, LARGE\_INC_{i,\,t} + error_{t+6,\,+10} \end{aligned} \tag{4}$$

where all variables are as defined in equation (3) with subscripts (t+6), (t+10) indicating the years over which the variable is averaged or cumulated.

Similar to the equation (3), we expect the coefficients β_2 through β_6 on proxies for business and information risk to be positive. Our test variable is IRDH. We expect β_0 and β_1 to be zero if all of the long-term excess return is accounted for by business and information risk, as well as the other risk factors. However, if β_1 is positive then it is indicative of a potential omitted risk factor.

Table 5, Panel A provides the descriptive statistics of the variables in equations (4) not already presented in earlier tables. The reported numbers are the mean of the annual means and the t-statistics are computed using the standard errors of the annual mean (see Fama and MacBeth (1973)). The abnormal return for the high (low) industry-adjusted R&D intensity firms is 2.54% (2.77%): a difference of roughly -8% = [2.54 – 2.77/ 2.77]. This is a substantial drop from the 110% difference in the short-term (see Table 4, Panel A). The difference in the long-term excess returns across the high and low groups is not statistically significant. This reversal provides an indication of potential mispricing (we investigate this more in the next sub-section). The difference in business risk across high and low groups is not statistically significant, but the difference in information risk continues to be statistically significant as in the short-term.

Table 5, Panel B provides the results of estimating equation (4). The coefficient on the standard deviation on earnings, SD(EPS), is positive and significant [β_2 = 0.8641 with t=3.73] and the coefficient on forecast dispersion is also positive and significant [β_5 = 0.0905 with t=2.72]. Thus, both information and business risks affect the long-term excess returns. Given that mean SD(EPS) and AvDISP in Panel A for high group is 0.0291 and 0.1606, the average effect of SD(EPS) and AvDISP in returns are 2.48% and 1.43%: for SD(EPS) it is calculated as (0.0291 × 0.8547) and for dispersion (0.1606 × 0.0892). Thus, on average both information and business risks are priced-in. Compared to the magnitudes of the average rate of return for business and information risk for the short-term, the magnitudes are substantially lower for the long-term. The degree of stability in the average rate of return for the short-term and long-term suggests that the business and information risks are priced-in risk factors.

Controlling for information and business risks, we find that the coefficient on the high group is not statistically significant [β_1 = 0.0036 with t=0.54]. The intercept estimate is also statistically not different from zero [β_1 = -0.0199 with t=-1.19]. This indicates that after controlling for information and business risks, high and low industry-adjusted R&D intensity firms earn zero excess returns in the long-term. In unreported analysis, without including any additional controls in equation (4) we obtain intercept and coefficient estimate on high industry-adjusted R&D intensity firms similar to the long-term univariate average reported in Table 5, Panel A. This indicates that information risk partly explains the long-term excess returns documented in Chambers et al. (2002).

Comparison of Short- and Long-term Excess Returns

We focus on the time-series pattern of the excess returns for each group, since a major characteristic of share mispricing is that investors learn over time, and "correct" the mispricing at some future date. Mispricing should therefore be reflected by reversal (or convergence) of excess returns. Indeed, we see that high industry-adjusted R&D intensity firms' short- and long-term returns are 5.25% (Table 4, Panel A) and 2.54% (Table 5, Panel A), respectively, indicating a clear reversal of returns attributable to mispricing. [21]

This return reversal is in stark contrast to Chamber et al. (2002). There are three potential reasons for this: (a) difference in sample, (b) passive truncation adjustment, and (c) the classification based on industry-adjustments. Chambers et al. consider the top three quintiles of R&D capital intensity without the restriction of two analysts and show that the short-term returns are similar in magnitude to the long-term returns. The top three quintiles correspond to our full sample, because we examine only firms with substantial R&D outlays. In untabulated analysis,

[21] For the whole group of high R&D firms, without separating high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms, we find a similar reversal, although of lower magnitude. In particular, the short- and long-term excess returns for high R&D firms are 5.40% and 2.24%, respectively. The magnitude of reversal is 2.00% less than Table 4. Thus, the classification of high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms using an industry benchmark helps to increase the short-term returns considerably.

for our full sample which roughly corresponds to that of Chambers et al., without using the passive truncation adjustment and restrictions on analyst following, we find that the short-term excess returns is roughly 5.14% and the long-term excess returns is 4.39%, a substantial reduction in the magnitude of the reversal.[22] However, when we classify this sample into high and low industry-adjusted R&D intensity firms, we find that the short- and long-term excess returns for high industry-adjusted R&D intensity firms are 6.67% and 4.32%, respectively: a significant reversal. This indicates the importance of the industry adjusted classification of R&D intensity. Overall, sample differences do not drive the result of return reversal of high industry-adjusted R&D intensity firms.

We also repeat our analysis using Chambers et al. (2002) procedure for computing future excess returns for our sample of firms with at least two analyst following. The untabulated results show that the short- and long-run excess returns for high industry-adjusted R&D intensity firms are 8.04% and 5.00%. The magnitude of the reversal is 3.03% for high industry-adjusted R&D intensity firms and is both economically and statistically significant. As such, the reversal of high industry-adjusted R&D intensity firms' future excess returns is attributable to the classification based on industry-adjustment which likely captures the differences in the nature of R&D activity. [23]

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[22] Chambers et al. substitute the companion portfolio return for non-surviving firms up until the end of the year of non-survival. In subsequent years the non-surviving firms are excluded from the computation of excess returns. In our passive truncation adjustment, we assume that the proceeds from the non-surviving firms are invested in value weighted index portfolio. While non-survival leads to passive truncations, the non-survival of the high and low groups are similar, and thus if the reversal is attributable to passive truncation alone, then we should observe reversals for both the high and low groups.

[23] In unreported analysis the results are qualitatively similar when either (a) the top two quintiles instead of top three quintiles are considered, or (b) we do not make any adjustment for firms' non-survival, i.e., passive truncations. For the bottom two quintiles not considered in our sample (a) the future excess returns are not statistically different from zero, (b) the difference in excess returns across high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms are not different from zero, and (c) the difference in excess returns across the short- and long-terms are not different from zero.

The average annual return difference between high and low industry-adjusted R&D intensity firms in the long-term is 0.08% which is statistically indistinguishable from zero. This indicates that the high and low industry-adjusted R&D intensity firms' long-term excess returns are identical. The equation (4) results in Table 5, Panel B indicates that accounting for risk factors (including business and information risk), long-term excess returns of both high and low industry-adjusted R&D intensity firms are statistically zero. As discussed earlier this reversal is indicative of mispricing.

In summary, our analysis indicates: (1) During the first five years after classification, high industry-adjusted R&D intensity firms are substantially undervalued by investors, after accounting for both business and information risks, and various general risk factors embedded in the size and book-to-market measures. (2) Beyond the first five years, the excess returns of high and low industry-adjusted R&D intensity firms converge, and essentially reflect both business and information risk factors. We note that these findings, indicating both an R&D undervaluation of high industry-adjusted R&D intensity firms in the short-term, and the impact of information risk on the entire series of subsequent returns of high industry-adjusted R&D intensity firms and low industry-adjusted R&D intensity firms, is documented here for the first time. These findings have, we believe, important policy implications, to be discussed in the concluding section.

V. Disclosure mitigates undervaluation

Empirical studies indicating undervaluation of R&D-intensive firms often attribute the undervaluation of the deficient disclosure regarding R&D and related innovation activities (e.g., Eberhart et al., 2004). Such attribution and the logical policy implications—extended disclosure—are frequently challenged with the argument that the researchers failed to show that extended disclosure would mitigate the undervaluation (e.g., Skinner, 2008). A valid criticism indeed.

To address this criticism and strengthen our policy recommendations we examine whether extended disclosures by firms mitigate the R&D-related undervaluation. As an indicator of extended disclosure we use the number of managements' earnings forecasts in a given year. While managements' earnings forecasts are often short-term, we assume that firms that have a communications strategy of providing short-term earnings guidance will also provide investors with long-term forward-looking information.

Specifically, we conjecture that the future excess returns of high industry-adjusted R&D intensity firms issuing more earnings guidance should be smaller than for those with fewer earnings guidance, given that some of the information conveyed by the guidance is related to R&D and its consequences. In the Appendix, we provide excerpts of a few companies' earnings guidance to illustrate that the guidance indeed contains information on R&D activities. In general, our perusal of several news releases of earnings guidance reveals that firms provide a variety of information: some provide information on R&D spending, and others provide information on new products that have been introduced, some provide information on the product pipeline. This is consistent with the recent findings of Jones (2007), and lends support for our conjecture.

The management forecast data is obtained from Thompson Financial First Call database which is available after 1994. Thus, we consider a sample from 1994 to 2001. For the empirical analysis in this section we consider all firms with R&D that appear in the First Call database.[24]

[24] We only consider firms with earnings guidance because firms without earnings guidance may be providing information to investors using other channels such as conference calls.

We estimate the following model to investigate the impact of guidance on the future excess returns to high industry-adjusted R&D intensity firms.

$$ARET_{i,\,t+1,t+3}=[Year\ Dummy]+\beta_1 IRDH_{i,\,t}+\beta_2 LN\_FORCST_{i,\,t}+\beta_{2D}\ LN\_FORCST_{i,\,t}*IRDH_{i,\,t} + \beta_3\ STD(EPS_{t+1,\,t+3}) + \beta_4\ STD(CFPS_{t+1,\,t+3})+\beta_5 AvER_{i,t+1,t+3}+\beta_6\ AvDISP_{i,t+1,t+3} + \beta_7 AvEP_{i,t+1,t+3} + \beta_8\ AvWCAQ_{i,\,t+1,\,t+3} + \beta_9\ LBM_{i,\,t} + \beta_{10}\ LLEV_{i,\,t} + \beta_{11}\ LMV_{i,\,t} + \beta_{12}\ EP +_{i,\,t} + \beta_{13}\ EP\_DUM_{i,\,t} + \beta_{14}\ LARGE\_INC_{i,\,t}+ error_{t+1,t+3} \quad (5)$$

$ARET_{i,t+1,t+3}$ is the average size and book-to-market adjusted returns over a three year period after portfolio formation (from t+1 to t+3). IRDH is one if a firm has a positive industry-adjusted R&D Capital–to–Sales in year t. LN_FORCST is log of the number of management forecast in year t. Equation (5) is estimated using panel data, and therefore we use the Huber-White procedure to correct for the standard errors (see Petersen (2005)). Based on our earlier results, we expect β_1 to be positive and based on the communications strategy conjecture we expect β_{2D} to be negative. We examine the average abnormal returns over subsequent three years because using return over five years decreases the sample size and test power considerably.[25]

Table 6 presents the results of estimating equation (5). The coefficient estimate on IRDH (β_1) is 4.32% and the coefficient estimate on the interaction of IRDH and managements' earnings forecasts term, (β_{2D}) is -2.42%. This indicates that about half of the short-term excess return of high industry-adjusted R&D intensity firms is mitigated by the earnings guidance release, providing support for the conjecture that the short-term excess returns (share undervaluation) are likely due to deficient information. This result is similar to the average short-term excess returns for high industry-adjusted R&D intensity firms reported in Table 4, suggesting that the average annual future excess returns in this sub-sample for the period 1994-2001 is similar to that in our main sample for the period 1975-1997.

[25] In unreported analysis we use the average excess returns over five years instead of three years and the interaction term is significant at the ten percent level: the sample period for this analysis is 1994-1999.

VI. Discussion

We set out to provide insights into a long-standing conundrum: Are the widely-documented subsequent excess returns to R&D-intensive firms due to share mispricing or risk? To this, we add another important question: If risk causes, fully or partially those subsequent excess returns, is it business and/or information risk? The importance of these questions mainly derives from the fact that both share mispricing and information risk has obvious disclosure policy implications.

Our battery of tests indicates: (a) The shares of high industry-adjusted R&D intensity firms are systematically undervalued during five years following classification. (b) This share undervaluation is cut by half when high industry-adjusted R&D intensity firms release earnings guidance, frequently discussing R&D-related issues. (c) Information risk affects the short- and long-term subsequent excess returns of both high and low industry-adjusted R&D intensity firms.

Regarding accounting policy implications, we note that our study goes beyond previous ones by documenting, not just conjecturing, that voluntary disclosure (earnings guidance) indeed mitigates the R&D-related undervaluation. This lends empirical support to the frequent calls for enhanced disclosure of R&D and other innovation activities of companies. Such disclosures include fundamental breakdowns of R&D outlays (e.g., basic research vs. development), and data on the consequences of R&D, such as "innovation revenues" (the percentage of periodic revenues from recently introduced products/services). Research on European companies, which have to provide "innovation revenue" data, shows that this measure is a powerful predictor of future firm performance (Crepon et al., 1998). Our aim in this study is to foster discussion on enhanced disclosure by innovative companies.

Appendix: Excerpts from Company Issued Guidance

1	**Genzyme ,** Feb. 16, 2001 R&D Spending: Research and Development spending will increase to between $155-$165 million, or 17-18 percent of revenue, in 2001. The increase in R&D spending compared to 2000 reflects three factors: (1) Genzyme General's assumption of the full cost of Renagel post-marketing clinical development efforts and the inclusion on the R&D line of this cost, which previously was included on the joint venture line; (2) increased spending to continue moving Genzyme's therapeutics pipeline forward rapidly; and (3) the addition of GelTex programs to pipeline. Clinical Development Programs: ….Genzyme expects to make substantial progress this year in moving a number of major products in its pipeline through the final stages of development and to begin clinical trials of several exciting products intended for larger patient populations…. … additional data related to its biologics license application for Fabrazyme… anticipates obtaining U.S. marketing approval for the product this year… actively enrolling MPS I patients in the pivotal Phase 3 trial of Aldurazyme(TM) (laronidase) enzyme replacement therapy… Among the products Genzyme is developing for larger patient populations is a polymer-based toxin binder for the treatment of C. difficile colitis.
2	**Cypress** , Jan. 23, 2001 Rodgers concluded, "… Our current forecast is for a modest 4% - 9% decline in revenues for the first quarter of 2001. That revenue combined with a tax rate increase to 30%, will lead us to an EBG of $0.58 per share in the first quarter… Cypress introduced a family of very high speed Programmable Serial Interface (PSI(TM)) communications products…The company believes LiTaO3 is a technology superior to the more well known lithium niobate (LiNio3) technology used for filters in mobile phones and laser modulators in 10-Gbps and 40-Gbps fiber transmission systems…Cypress announced samples of the world's first integrated USB 2.0 controller solution.
3	**Biogen**, Jan. 17, 2001 Pending successful conclusion of the trials, we anticipate product registration and launch in the second half of 2002…. We also expect to report Phase II results from studies of ANTEGREN(R) (natalizumab) in MS and Crohn's disease during the first quarter of this year in conjunction with our partner, Elan Pharmaceuticals….In addition, we expect to double our clinical pipeline this year with the introduction of three new drugs into the clinic… During the past year, we refocused our research priorities into four key areas in which we have a competitive research advantage and where there are significant clinical and commercial opportunities -- autoimmune disease, neurological disease, cancer and fibrosis. **…**For 2001, the Company expects earnings per share will be in a range of $1.90 - $1.98.
4	**Amgen** Jan. 25, 2000 Taking into account the Y2K stocking that actually occurred in 1999, the Company expects that in 2000, EPOGEN sales growth will be in the low-teens, that NEUPOGEN sales growth will be at a mid single-digit rate, total product sales growth will be in the high single-digits and that earnings per share will be in a range of$1.05-$1.07.…During the fourth quarter, Amgen submitted regulatory license applications for both NESP and Kineret…Also in the fourth quarter, Amgen and PRAECIS PHARMACEUTICALS completed two phase 3 trials evaluating abarelix in prostate cancer patients…These are both exciting and challenging times for our Company as we continue to make the investments necessary to maximize the value of our products and ensure the long-term success of Amgen.
5	**Motorola,** Apr 11, 2000 Robert Growney, president and chief operating officer, said: "Motorola's growth in sales has continued to accelerate, and our earnings are on an improving trend…Motorola introduced a total of 20 wireless phones with a continued focus on Internet-ready products for a variety of consumers…The company also introduced three new messaging devices and its next-generation series of consumer two-way radios. …Motorola demonstrated the world's first Internet-enabled location service over a GPRS network using the Wireless Application Protocol…Motorola announced an effort to begin the standardization process for 1XTREME technology, which will offer operators a migration path to provide integrated voice and data speeds of more than 5 megabits per second on their existing CDMA infrastructure.
6	**Schering-Plough**, July 12, 2000 Schering-Plough's earnings per share for the full year are expected to be in line with the current consensus of analysts' estimates of $1.64, which would give us our 15th consecutive year of double-digit growth… Schering-Plough **R**esearch Institute (SPRI) presented a review of research organization and strategies, drug discovery programs, and the progress of leading compounds in key therapeutic areas
7	**Intel**, Sept. 21, 2000 BODY: Intel's **t**hird quarter revenue is anticipated to be below the company's previous expectations, primarily due to weaker demand in Europe…. Expenses (R&D**,** excluding in-process R&D, plus MG&A) in the third quarter of 2000 are expected to be up 7 to 9 percent from second quarter expenses of $2.2 billion, primarily due to higher spending on marketing programs and R&D initiatives in new business areas. Expenses are dependent in part on the level of revenue… R&D spending, excluding in-process R&D, is expected to be approximately $4.0 billion for 2000.

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TABLE 1: Descriptive Statistics

Panel A: Number of Firms by Years

Year	High Group	Low Group
1979	140	108
1980	149	119
1981	155	128
1982	193	128
1983	195	166
1984	191	180
1985	185	161
1986	197	149
1987	199	151
1988	225	115
1989	226	132
1990	240	132
1991	248	135
1992	283	149
1993	281	185
1994	348	160
1995	390	159
1996	486	170
1997	490	143
Average number of firms	253	146

Panel B: R&D intensity of high and low groups in future years

	High Group	Low Group	Not-in-Sample	High Group	Low Group	Not-in-Sample
Contemporaneous	100.00	0	0	0	100.00	0
1-year after	91.45	5.89	2.66	15.16	82.71	2.13
2-year after	81.85	8.44	9.71	21.81	70.07	8.12
3-year after	72.89	10.21	16.91	23.86	61.73	14.40
4-year after	65.71	11.26	23.02	23.89	55.68	20.43
5-year after	59.49	11.93	28.58	22.35	51.62	26.03

Panel C: Reasons for 'Not-in-sample' in Panel B

	High Group			Low Group		
	M&A	Performance	Other	M&A	Performance	Other
1-year after	76.39	16.68	6.93	82.26	12.29	5.45
2-year after	79.52	15.08	5.40	81.05	11.08	7.87
3-year after	79.80	14.02	6.18	81.59	11.23	7.18
4-year after	80.49	13.52	5.99	81.26	11.34	7.40
5-year after	80.28	13.38	6.34	80.40	11.98	7.62

Panel D: Descriptive Statistics

	High Group	Low Group	Difference = High Group minus Low Group t-stat.
R&D capital to sales	0.3007	0.1107	6.07*
R&D capital to market	0.2518	0.1464	7.11*
Book-to-market	0.5900	0.6263	-1.69
Dividend yield	0.0126	0.0149	-0.98
Sales growth	0.3621	0.2552	2.02*
OpROA	0.2521	0.2237	2.68*
Market share	0.0313	0.0268	1.84
Market value of equity	1464.90	1409.63	0.21
Sales revenue	1661.14	1451.34	1.95*
Operating income before R&D	371.45	311.42	2.06*
Total assets	1718.31	1354.33	2.19*
Book value of equity	669.88	528.01	2.78*

Notes:
1. The sample contains all domestic R&D firms covered in CRSP, IBES and COMPUSTAT with sales greater than $10 million and total assets greater than $5 million, with at least two analysts and belonging to the top three quintiles of the R&D Capital to Sales ratio for the period 1975 to 1997.
2. Panel D reports the mean value of annual means. The t-stat column is the test statistic for the difference in mean where the Difference = High industry-adjusted R&D intensity firms (t) minus Low industry-adjusted R&D intensity firms (t). The t-statistics in Panel D are calculated using the standard errors of the annual means (Fama and MacBeth (1973)).
3. Panel C summarizes the reasons for why a firm is 'not-in-sample' in Panel B. Data for this purpose is obtained from the delisting codes in CRSP (see Shumway (1997)). M&A is merger and acquisition (delisting code of 200-240). Performance is delisting due to performance (delisting codes 500, 520-584). Other is all other delisting categories such as change in exchange, still active, Liquidations, etc.
4.* denotes significance at 5 percent level.

Variable Definitions:
R&D capital is computed by capitalizing and amortizing R&D expenditures (Compustat data item # 46) over five years. If a firm has a positive industry-adjusted R&D Capital to Sales (Compustat data item # 12) in year t, it is classified as high industry-adjusted R&D intensity group, and low otherwise. The industry-adjusted R&D capital to sales is R&D capital to sales for a given firm minus industry's value-weighted R&D capital to sales. Industry definitions are the 48 industry groups as in Fama and French (1997). Market value is calculated as share outstanding times share price at the end of April. Sales growth is change in sales (Compustat data item # 12) between year (t) and year-(t-1) divided by sales in year (t-1). Operating income before R&D is operating income (Compustat data item # 13) plus R&D expenditures (Compustat data item # 46). OpROA is operating income before R&D expenditures divided by total assets. Market share is sales revenue in a given year divided by sum of sales revenue in firm's industry. Book-to-market ratio is book value of equity (Compustat data item # 60) divided by market value of equity. Dividend yield is dividend (Compustat data item # 21) divided by market value of equity. Total asset is Compustat data item # 6.

TABLE 2: Standard Deviation of Future Earnings and Cash Flows

Panel A: Descriptive Statistics

	High Group	Low Group	Difference = High Group minus Low Group t-stat.
SD($EPS_{t+1,\ +5}$)	0.0319	0.0293	1.72
SD($CFPS_{t+1,\ +5}$)	0.0321	0.0345	-1.36
R&DM	0.0984	0.0629	7.39*
CapEx	0.0749	0.0926	-2.04*
LMV	-1.519	-1.730	-0.22
LEV	0.11501	0.1805	-2.21*

Panel B: Estimating Equation (1)

	Dependent variable = SD($EPS_{t+1,\ t+5}$) Coeff.	Dependent variable = SD($EPS_{t+1,\ t+5}$) t.stat.	Dependent variable = SD($CFPS_{t+1,\ t+5}$) Coeff.	Dependent variable = SD($CFPS_{t+1,\ t+5}$) t.stat.
IRDH	0.0007	0.32	0.0001	0.09
IRDH * R&DM	-0.0388	-2.36*	-0.0623	-3.99*
R&DM	0.1053	5.45*	0.1366	7.56*
CapEx	0.0049	0.67	-0.0008	-0.11
LMV	-0.0051	-26.82*	-0.0058	-17.85*
LEV	0.0163	4.68*	0.0137	4.60*
R-square	0.2972		0.3104	

Notes:

1.The sample contains all domestic R&D firms covered in CRSP, IBES and COMPUSTAT with sales greater than $10 million and total assets greater than $5 million, with at least two analysts and belonging to the top three quintiles of the R&D Capital to Sales ratio for the period 1975 to 1997.

2.Equation (1): SD= [Industry Fixed Effects] + β_{1t} $IRDH_{i,t}$ + β_{12t} $IRDH_{i,\ t}$ * $R\&DM_t$ + β_{2t} $R\&DM_t$ + β_{3t} $CapEx_t$ +$\beta_{4t}LMV_t$+$\beta_{5t}LEV_t$+$error_{t+1,t+5}$.

3.Panel A reports the mean value of annual means for descriptive statistics. The t-stat column is the test statistic for the difference in mean where the Difference = High industry-adjusted R&D intensity firms (t) minus Low industry-adjusted R&D intensity firms (t). The t-statistics are calculated using the standard errors of the annual means (Fama and MacBeth (1973)). Panel B reports the mean coefficient estimates and t-statistics from annual cross-sectional estimation of equation (1). The t-statistics in Panel B are calculated using the standard errors of the annual coefficient estimates.

4.All variables except EPS, and CFPS are winsorized at 1% and 99% of the annual distributions. EPS and CFPS are winsorized at +1 and -1.

5.* denotes significance at 5 percent level.

Variable Definitions:

R&D capital is computed by capitalizing and amortizing R&D expenditures (Compustat data item # 46) over five years. If a firm has a positive industry-adjusted R&D Capital to Sales (Compustat data item # 12) in year t, it is classified as high industry-adjusted R&D intensity group, and low otherwise. The industry-adjusted R&D capital to sales is R&D capital to sales for a given firm minus industry's value-weighted R&D capital to sales. Industry definitions are the 48 industry groups as in Fama and French (1997). IRDH is one if a firm is classified in the high group in year t and zero otherwise. R&DM is R&D expenditure per share divided by share price. CapEx is capital expenditures (Compustat data item # 128) per share divided by share price. LMV is the natural log of market value of equity in April in $ billions. LEV is the sum of long-term debt, (Compustat data item # 9) and debt in current liabilities (Compustat data item # 34), divided by sum of debt and market value of equity. EPS is earnings per share before extraordinary times and discontinued operations (Compustat data item # 58). CFPS is cash flow from operations deflated by number of shares outstanding (Compustat data item # 54). Cash flow from operations is Compustat data item # 308 for years 1987-1997. For 1975-1986, cash flow from operations = fund from operations - (Δ current assets + Δ debt in current liabilites - Δ current liabilites - Δ cash). SD($EPS_{t+1,\ +5}$) is standard deviation of earnings per share. SD($CFPS_{t+1,\ +5}$) is standard deviation of cash flows per share. Standard deviation is calculated using five annual observations for years t+1 through t+5. When EPS or CFPS data are missing in any of the years from t+1 through t+5 standard deviation is set equal to mean standard deviation of the firms in the same Altman Z-Score decile portfolio.

TABLE 3: Analyst Forecast Error and Dispersion

Panel A: Descriptive Statistics

	High Group	Low Group	Difference = High Group minus Low Group t-stat.
A_ERROR	0.68512	0.5148	3.46*
DISP	0.2089	0.1512	3.57*
WCAQ	0.0591	0.0541	1.17
STDROE	0.1805	0.1685	1.08
CORR	0.1407	0.1154	1.86
ACHEPS	0.0571	0.0499	0.86
ROA	0.0344	0.0702	4.66*
PROA	0.0437	0.0621	2.07*

Panel B: Estimating Equation (2)

	Dependent variable = A_ERROR_{t+1}		Dependent variable = $DISP_{t+1}$		Dependent variable = WCAQ	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
IRDH	0.0612	1.92*	0.0412	3.91*	-0.0031	-1.17
IRDH * R&DM	2.3242	2.89*	0.3548	2.19*	0.0928	4.06
R&DM	-0.3123	-0.45	-0.1743	-1.38	-0.0503	-3.06*
LMV	-0.1663	-8.95*	-0.0293	-7.82*	-0.0081	-7.46
STDROE	0.1097	1.09	0.0652	0.63	0.0353	1.83
CORR	0.0885	1.01	0.0398	0.89	0.0215	1.05
ACHEPS	0.09762	5.02*	0.5421	5.13*	0.0190	2.18*
ROA	-4.0506	-6.28*	-1.1767	-8.32*	-0.0472	-1.99*
PROA	-0.8052	-1.78	-0.3126	-1.79	-0.0513	-1.47
Adjusted R-square	0.2167		0.2597		0.3677	

Notes:

1.The sample contains all domestic R&D firms covered in CRSP, IBES and COMPUSTAT with sales greater than $10 million and total assets greater than $5 million, with at least two analysts and belonging to the top three quintiles of the R&D Capital to Sales ratio for the period 1975 to 1997.Analyst data is obtained from IBES Summary Files.

2.Panel A reports the mean value of annual means for descriptive statistics. The t-stat column is the test statistic for the difference in mean where the Difference = High industry-adjusted R&D intensity firms (t) minus Low industry-adjusted R&D intensity firms (t). The t-statistics are calculated using the standard errors of the annual means (Fama and MacBeth (1973)). Panel B reports the mean coefficient estimates and t-statistics from cross-sectional estimation of equation (2). The t-statistics in Panel B are calculated using the standard errors of the annual coefficient estimates.

3.Equation (2): {AERROR, DISP, WCAQ} = [Industry Fixed Effects] + β_{1t} IRDH + β_{12t} IRDH * R&DM + β_{2t} R&DM + β_{3t} STDROE $+\beta_{4t}LMV_t+\beta_{5t}CORR+\beta_{6t}ACHEPS+\beta_{7t}ROA+\beta_{8t}PROA+error_{t+1}$.

4.* denotes significance at 5 percent.

<u>Variable Definitions:</u>

R&D capital is computed by capitalizing and amortizing R&D expenditures (Compustat data item # 46) over five years. If a firm has a positive industry-adjusted R&D Capital to Sales (Compustat data item # 12) in year t, it is classified as high industry-adjusted R&D intensity group, and low otherwise. The industry-adjusted R&D capital to sales is R&D capital to sales for a given firm minus industry's value-weighted R&D capital to sales. Industry definitions are the 48 industry groups as in Fama and French (1997). Analysts' forecast error and dispersion are measured in May of year t+1. A_ERROR is absolute forecast error, which is the absolute value of the difference between actual earnings and median analyst forecast scaled by absolute value of median forecast. DISP is dispersion, which is the standard deviation of analysts' forecasts divided by absolute median analyst forecast. WCAQ is the quality of working capital accruals. It is the standard deviation of firm-specific residuals from regression of working capital accruals on the cash flows over years t-1, t and t+1 as in Dechow and Dechow (2002). The estimation is performed each year and industry using data over years t to t-4. The industry definitions are 48 Fama and French industry definitions. LMV is log of market value of equity in April in billions. Market value of equity is share price at April multiplied by shares outstanding. STDROE is standard deviation of return on equity (ROE) in preceding five-year period. Return on equity is earnings before extraordinary items (data18) divided by book value of equity (Compustat data item # 60). ACHEPS is absolute value of change in earnings per share (Compustat data item # 58) divided by share price. CORR is the Pearson correlation between annual return and ROE in preceding five-year period. ROA is return on assets defined as earnings before extraordinary items divided by total assets (Compustat data item # 6). PROA is the average of five years earnings divided by average of five year total assets. R&DM is R&D expenditure per share divided by share price.

Table 4: Future Short-term Excess Returns

Panel A: Descriptive Statistics

	High Group	Low Group	Difference = High minus Low t-stat.
$ARET_{t+1, +5})$	0.0525	0.0249	2.21*
$SD(EPS_{t+1, +5})$	0.0319	0.0293	1.72
$SD(CFPS_{t+1, +5})$	0.0321	0.0345	-1.36
$AvER_{i, t+1, +5}$	0.6532	0.5411	3.98*
$AvDISP_{i, t+1, +5}$	0.1931	0.1536	3.95*
$AvEP_{t+1, t+5}$	0.0513	0.0689	-1.90
$AvWCAQ_{t+1, t+5}$	0.0578	0.0551	0.86

Panel B: Estimating Equation (3)

	Coeff	t-stat.	Coeff	t-stat.
Intercept	-0.0201	-2.58*	-0.01209	-3.97*
$IRDH_t$	0.0234	4.69*	0.0318	5.35*
$STD(EPS_{t+1, t+5})$	1.0241	5.21*		
$STD(CFPS_{t+1, t+5})$	-0.1061	-1.19		
$AvER_{i, t+1, +5}$	0.0279	1.39		
$AvDISP_{i, t+1, +5}$	0.1761	4.11*		
$AvWCAQ_{t+1, t+5}$	-0.4012	-1.89		
$AvEP_{t+1, t+5}$	0.8761	12.42*	0.7324	8.21*
LBM_t	-0.0131	-2.11*	-0.0042	-0.81
$LLEV_t$	0.0002	0.23	0.0012	0.83
LMV_t	-0.0015	-0.81	-0.0083	-4.53*
$EP(+)_t$	-0.1621	-1.81	-0.1942	-1.89
EP_DUM_t	-0.0060	-0.52	0.0160	1.76
$LARGE\_INC_t$	0.0178	1.97*	0.0183	2.05*
Mean Adjusted R-square	0.2671		0.1708	

Notes:

1.The sample contains all domestic R&D firms covered in CRSP, IBES and COMPUSTAT with sales greater than $10 million and total assets greater than $5 million, with at least two analysts and belonging to the top three quintiles of the R&D Capital to Sales ratio for the period 1975 to 1997.

2.Equation (5): $ARET_{i, t+1, +5} = \beta_0 + \beta_1 IRDH_{i, t} + \beta_2 SD_i(EPS_{t+1, +5}) + \beta_3 SD_i(CFPS_{t+1, +5}) + \beta_4 AvFER_{i, t+1, +5} + \beta_5 AvDISP_{i, t+1, +5} + \beta_6 AvWCAQ_{i, t+1, +5} + \delta_1 AvEP_{i, t+1, +5} + \delta_2 LBM_{i, t} + \delta_3 LLEV_{i, t} + \delta_4 LMV_{i, t} + \delta_5 EP+_{i, t} + \delta_6 EP\_DUM_{i, t} + \delta_7 LARGE\_INC_{i, t} + error_{t+1,t+5}$

3.The t-statistics are calculated using the standard errors of the annual coefficient estimates based on Fama and MacBeth (1973) procedure.

4.All variables except the dependant variable are winsorized at 1% and 99% of the annual distributions.

5.* denotes significance at 5 percent level.

Variable Definitions:

R&D capital is computed by capitalizing and amortizing R&D expenditures (Compustat data item # 46) over five years. If a firm has a positive industry-adjusted R&D Capital to Sales (Compustat data item # 12) in year t, it is classified as high industry-adjusted R&D intensity group, and low otherwise. The industry-adjusted R&D capital to sales is R&D capital to sales for a given firm minus industry's value-weighted R&D capital to sales. Industry definitions are the 48 industry groups as in Fama and French (1997). IRDH is one if a firm is classified in the high group. $ARET_{t+1, +5}$ is the average of the excess returns over short horizon (i.e. from (t+1) to (t+5)). The excess returns are size and book-to-market adjusted returns. The excess returns are computed using the companion portfolio approach. Each firm in the sample is assigned to a companion portfolio based on its ranking by size and book-to-market. For the companion portfolio the book-to-market ratios are classified into five equal groups at the end of April each year; the size breakpoints are determined by classifying the NYSE companies into five equal groups in April each year. The group representing the smallest size is further divided into two equal groups. The monthly excess returns are then computed as the difference the firm's monthly return minus the companion portfolio's monthly return. The annual excess returns are obtained by compounding the monthly excess returns from May to April of next year. SD(EPS) is the standard deviation of earnings per share (as defined in Table 2) over the short- and long-terms scaled by stock price. SD(CFPS) is the standard deviation of cash flow from operations (as defined in Table 2) over the short- and long-terms scaled by stock price. AvEP is the average earnings over the short- and long-terms scaled by share price. Analyst forecast error and dispersion AvER is the average absolute analysts' forecast error over the short- and long-terms scaled by absolute median analyst forecast. Analysts' forecast error is the median analyst forecast minus actual earnings. AvDISP is the average dispersion in analyst forecasts over the short- and long-terms scaled by absolute median analyst forecast in year t+1. All analyst forecast variables are measured in May from IBES Summary Files. AvWCAQ is the mean of WCAQ from t+1 to t+5. WCAQ is the quality of working capital accruals. It is the standard deviation of firm-specific residuals from regression of working capital accruals on the cash flows over years t-1, t and t+1 as in Dechow and Dechow (2002). The estimation is performed each year and industry using data over years t to t-4. The industry definitions are 48 Fama and French industry definitions. EP(+) is the earnings-to-price ratio if EP is positive and zero otherwise. Earning-to-price ratio is earnings before extraordinary items (Compustat data item # 18) divided by market value of equity. AvEP is the mean of earnings-to-price ratio over the period specified in the subscript. EP_DUM is one if the current earnings to price ratio is negative. LBM is the log of book-to-market ratio. Book-to-market ratio is book value of equity (Compustat data item # 60) divided by market value of equity. LMV is the natural logarithm of the market value of equity in April. LLEV is natural logarithm of the ratio of book value of debt (Compustat data item # 9 plus Compustat data item # 34) to the market value of equity plus debt. LARGE_INC is an indicator variable which equals one if the firm has R&D intensity (R&D to asset and R&D to sales ratios) of at least 5%, the change in R&D to asset ratio and dollar value of R&D is at least 5% (i.e. increasing R&D to asset ratio from 5% to at least 5.25%).

Table 5: Future Long-term Excess Returns

Panel A: Descriptive Statistics

	High Group	Low Group	Difference = High minus Low t-stat.
$ARET_{t+6, +10})$	0.0254	0.0277	-0.37
$STD(EPS_{t+6, t+10})$	0.0291	0.0280	0.92
$STD(CFPS_{t+6, t+10})$	0.0287	0.0299	-0.87
$AvER_{i, t+6, +10}$	0.4663	0.3946	2.59*
$AvDISP_{i, t+6, +10}$	0.1606	0.1371	2.68*
$AvWCAQ_{t+6\ \ t+10}$	0.0561	0.0554	0.32
$AvEP_{t+6, t+10}$	0.1023	0.1210	1.14

Panel B: Estimating Equation (4)

	Coeff	t-stat.	Coeff	t-stat.
Intercept	-0.0169	-1.19	0.0105	1.07
$IRDH_t$	0.0036	0.54	0.0088	0.83
$STD(EPS_{t+6, t+10})$	0.8641	3.73*		
$STD(CFPS_{t+6, t+10})$	-0.0261	-0.41		
$AvER_{i, t+6, +10}$	-0.0121	-1.23		
$AvDISP_{i, t+6, +10}$	0.0905	2.72*		
$AvWCAQ_{t+1, t+5}$	-0.2945	-1.81		
$AvEP_{t+6, t+10}$	0.2162	8.93*	0.2202	6.41*
LBM_t	-0.0070	-0.83	-0.0021	-0.35
$LLEV_t$	0.0043	1.85	0.0033	1.51
LMV_t	0.0004	0.18	-0.0038	-2.29*
$EP(+)_t$	-0.1165	-1.01	-0.09889	-1.18
EP_DUM_t	-0.0241	-1.12	-0.0179	-1.69
$LARGE\_INC_t$	0.0070	0.89	0.0081	1.04
Mean Adjusted R-square	0.1762		0.0867	

Notes:

1.The sample contains all domestic R&D firms covered in CRSP, IBES and COMPUSTAT with sales greater than $10 million and total assets greater than $5 million, with at least two analysts and belonging to the top three quintiles of the R&D Capital to Sales ratio for the period 1975 to 1997.

2.Equation (6): $ARET_{i, t+6, +10} = \beta_0 + + \beta_1 IRDH_{i, t} + \beta_2 SD_i(EPS_{t+6, +10}) + \beta_3 SD_i(CFPS_{t+6, +10}) + \beta_4 AvFER_{i, t+6, +10} + \beta_5 AvDISP_{i, t+6, +10} +$ $+ \beta_6 AvWCAQ_{i, t+6, +10} + \delta_1 AvEP_{i, t+6, +10} + \delta_2 LBM_{i, t} + \delta_3 LLEV_{i, t} + \delta_4 LMV_{i, t} + \delta_5 EP+_{i, t} + \delta_6 EP\_DUM_{i, t} + \delta_7 LARGE\_INC_{i, t} + error_{t+6,t+10}$

3.The t-statistics are calculated using the standard errors of the annual coefficient estimates based on Fama and MacBeth (1973) procedure.

4.All variables except the dependant variable are winsorized at 1% and 99% of the annual distributions.

5.* denotes significance at 5 percent level.

Variable Definitions:

R&D capital is computed by capitalizing and amortizing R&D expenditures (Compustat data item # 46) over five years. If a firm has a positive industry-adjusted R&D Capital to Sales (Compustat data item # 12) in year t, it is classified as high industry-adjusted R&D intensity group, and low otherwise. The industry-adjusted R&D capital to sales is R&D capital to sales for a given firm minus industry's value-weighted R&D capital to sales. Industry definitions are the 48 industry groups as in Fama and French (1997). IRDH is one if a firm is classified in the high group. $ARET_{t+6,+10}$ is the average of the excess returns over long horizon (i.e. from (t+6) to (t+10)). The excess returns are size and book-to-market adjusted returns. The excess returns are computed using the companion portfolio approach. Each firm in the sample is assigned to a companion portfolio based on its ranking by size and book-to-market. For the companion portfolio the book-to-market ratios are classified into five equal groups at the end of April each year; the size breakpoints are determined by classifying the NYSE companies into five equal groups in April each year. The group representing the smallest size is further divided into two equal groups. The monthly excess returns are then computed as the difference the firm's monthly return minus the companion portfolio's monthly return. The annual excess returns are obtained by compounding the monthly excess returns from May to April of next year. SD(EPS) is the standard deviation of earnings per share (as defined in Table 2) over the short- and long-terms scaled by stock price. SD(CFPS) is the standard deviation of cash flow from operations (as defined in Table 2) over the short- and long-terms scaled by stock price. AvEP is the average earnings over the short- and long-terms scaled by share price. Analyst forecast error and dispersion AvER is the average absolute analysts' forecast error over the short- and long-terms scaled by absolute median analyst forecast. Analysts' forecast error is the median analyst forecast minus actual earnings. AvDISP is the average dispersion in analyst forecasts over the short- and long-terms scaled by absolute median analyst forecast in year t+1. All analyst forecast variables are measured in May from IBES Summary Files. AvWCAQ is the mean of WCAQ from t+6 to t+10. WCAQ is the quality of working capital accruals. It is the standard deviation of firm-specific residuals from regression of working capital accruals on the cash flows over years t-1, t and t+1 as in Dechow and Dechow (2002). The estimation is performed each year and industry using data over years t to t-4. The industry definitions are 48 Fama and French industry definitions. EP(+) is the earnings-to-price ratio if EP is positive and zero otherwise. Earning-to-price ratio is earnings before extraordinary items (Compustat data item # 18) divided by market value of equity. AvEP is the mean of earnings-to-price ratio over the period specified in the subscript. EP_DUM is one if the current earnings to price ratio is negative. LBM is the log of book-to-market ratio. Book-to-market ratio is book value of equity (Compustat data item # 60) divided by market value of equity. LMV is the natural logarithm of the market value of equity in April. LLEV is natural logarithm of the ratio of book value of debt (Compustat data item # 9 plus Compustat data item # 34) to the market value of equity plus debt. LARGE_INC is an indicator variable which equals one if the firm has R&D intensity (R&D to asset and R&D to sales ratios) of at leat 5%, the change in R&D to asset ratio and dollar value of R&D is at least 5% (i.e. increasing R&D to asset ratio from 5% to at least 5.25%).

TABLE 6: Management Forecasts and Future Excess Returns

Variable	Equation (5) Coeff.	Equation (5) t-stat	Equation (5) without Business and Information Risk Coeff.	Equation (5) without Business and Information Risk t-stat	Equation (5) without Guidance, Leader Interaction and Business and Information Risk Coeff.	Equation (5) without Guidance, Leader Interaction and Business and Information Risk t-stat
$IRDH_t$	0.0432	3.71*	0.0451	3.78*	0.0417	3.57*
LN_FORCST_t	0.0023	0.15	0.0021	0.10	-0.0162	-1.82
LN_FORCST_t * $IRDH_t$	-0.0242	-1.66	-0.0293	-1.91*		
$STD_i(EPS_{t+1,\ t+3})$	0.9769	4.98*				
$STD_i(CFPS_{t+1,\ t+3})$	0.0569	0.51				
$AvER_{i,\ (t+1,\ +3)}$	0.0318	2.04*				
$AvDISP_{i,\ t+1,\ +3}$	0.1171	1.99*				
$AvWCAQ_{t+1,\ t+3}$	-0.2655	-1.75				
$AvEP_{t+1,\ t+3}$	0.4879	8.05*	0.2845	5.96*	0.2745	5.71*
LBM_t	-0.0321	-2.98*	-0.0274	-2.81*	-0.0289	-2.93*
$LLEV_t$	0.0038	0.79	0.0030	0.60	0.0037	0.75
LMV_t	-0.0209	-4.31*	-0.0275	-7.18*	-0.0269	-6.08*
$EP(+)_t$	-0.3962	-1.79	-0.3574	-1.87	-0.3765	-1.89
EP_DUM_t	-0.0192	-1.03	-0.0185	-0.62	-0.0178	-0.69
$LARGE\_INC_t$	0.0191	2.02*	0.0209	2.18*	0.0211	2.17*
Adjusted R-square	0.2045		0.1441		0.1432	

Notes:

1. The sample contains all domestic R&D firms covered in CRSP, IBES and COMPUSTAT with sales greater than $10 million and total assets greater than $5 million, with at least two analysts and belonging to the top three quintiles of the R&D Capital to Sales ratio for the period 1994 to 2001.
2. Equation (5): $ARET_{i,\ t+1,t+3}$ = [Year Dummies] + $\beta_1 IRDH_{i,\ t} + \beta_2 LN\_FORCST_{i,\ t} + \beta_{2D}\ LN\_FORCST_{i,\ t}\ IRDH_{i,\ t} + \beta_3\ STD(EPS_{t+1,\ t+3})$ $+ \beta_4\ STD(CFPS_{t+1,\ t+3}) + \beta_5\ AvER_{i,\ t+1,\ t+3} + \beta_6\ AvDISP_{i,\ t+1,\ t+3} + \beta_7\ AvEP_{i,\ t+1,\ t+3} + \beta_8\ AvWCAQ_{i,\ t+1,\ t+3}$ $+ \beta_9\ LBM_{i,\ t} + \beta_{10}\ LLEV_{i,\ t} + \beta_{11}\ LMV_{i,\ t} + \beta_{12}\ EP+_{i,\ t} + \beta_{13}\ EP\_DUM_{i,\ t} + \beta_{14} LARGE\_INC_{i,\ t} + error_{t+1,t+3}$.
3. The t-statistics are calculated using the standard errors obtained from the Huber-White procedure (Petersen (2005)).
4. All variables except the dependant variable are winsorized at 1% and 99% of the annual distributions.
5. * denotes significance at 5 percent level.

<u>Variable Definitions:</u>
R&D capital is computed by capitalizing and amortizing R&D expenditures (Compustat data item # 46) over five years. If a firm has a positive industry-adjusted R&D Capital to Sales (Compustat data item # 12) in year t, it is classified as high industry-adjusted R&D intensity group, and low otherwise. The industry-adjusted R&D capital to sales is R&D capital to sales for a given firm minus industry's value-weighted R&D capital to sales. Industry definitions are the 48 industry groups as in Fama and French (1997). $ARET_{i,t+1,t+3}$ is the average size and book-to-market adjusted returns over three year period after portfolio formation (from t+1 to t+3). The calculation of excess returns is described in Table 4. IRDH is an indicator variable which equals one if a firm is classified in the high group in year t. LN_FORCST is log of the number of management forecasts in a year t from FIRSTCALL. SD(EPS) is the standard deviation of earnings per share (as defined in Table 2) over years t+1 to t+3 scaled by stock price. SD(CFPS) is the standard deviation of cash flow from operations (as defined in Table 2) over years t+1 to t+3 scaled by stock price. AvEP is the average earnings over years t+1 to t+3 scaled by share price. Analyst forecast error and dispersion AvER is the average absolute analysts' forecast error over years t+1 to t+3 scaled by absolute median analyst forecast. Analysts' forecast error is the median analyst forecast minus actual earnings. AvDISP is the average dispersion in analyst forecasts over years t+1 to t+3 scaled by absolute median analyst forecast in year t+1. All analyst forecast variables are measured in May from IBES Summary Files. EP(+) is the earnings-to-price ratio if EP is positive and zero otherwise. Earning-to-price ratio is earnings before extraordinary items (Compustat data item #18) divided by market value of

equity. AvEP is the mean of earnings-to-price ratio over the period specified in the subscript. AvWCAQ is the mean of WCAQ from t+1 to t+3. WCAQ is the quality of working capital accruals. It is the standard deviation of firm-specific residuals from regression of working capital accruals on the cash flows over years t-1, t and t+1 as in Dechow and Dechow (2002). The estimation is performed each year and industry using data over years t to t-4. The industry definitions are 48 Fama and French industry definitions. EP_DUM is one if the current earnings to price ratio is negative. LBM is the log of book-to-market ratio. Book-to-market ratio is book value of equity (Compustat data item # 60) divided by market value of equity. LMV is the natural logarithm of the market value of equity in April. LLEV is natural logarithm of the ratio of book value of debt (Compustat data item # 9 plus Compustat data item # 34) to the market value of equity plus debt, both at the end of year t. LARGE_INC is an indicator variable which equals one if the firm has R&D intensity (R&D to asset and R&D to sales ratios) of at least 5%, the change in R&D to asset ratio and dollar value of R&D is at least 5% (i.e. increasing R&D to asset ratio from 5% to at least 5.25%).