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The effect of R&D on future returns and earnings forecasts

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Abstract Prior studies attribute the future excess returns of research and development activity (R&D) firms to either compensation for increased risk or to mispricing. We suggest a third explanation and show that neither the level of R&D investment nor the change in R&D investment explains future returns. Rather, the positive future returns that prior studies attribute to R&D investment are actually due to the component of the R&D firm's realized return that is unrelated to R&D investment but present in R&D firms. Our results suggest that the excess returns of R&D firms are part of the larger value/growth anomaly. In addition, we show that while future earnings are positively associated with current R&D, errors in earnings expectations by investors and analysts are not related to R&D investment.

Keywords R&D · Value/growth · Investment · Mispricing · Earnings forecasts · Analysts

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1 Introduction

This study examines the relation between research and development activity (R&D), earnings forecasts, and future stock returns. Prior research finds positive

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associations between future stock returns and current R&D intensity (for example, Chan et al. 2001; Chambers et al. 2002) and current R&D growth (for example, Penman and Zhang 2002; Eberhart et al. 2004). Some studies suggest that the future returns associated with R&D firms are compensation for risk, while other studies suggest that investors misprice the earnings of R&D firms leading to predictable future return patterns (Lev et al. 2005).

Our study suggests a third explanation for the future returns of R&D firms. Specifically, our results suggest there is no direct relation between a firm's R&D investment and future returns. Rather, the significant future returns of R&D firms noted in prior studies are due to differences in investor expectations about future earnings and asset growth that are not directly related to R&D. These differences in investor expectations are consistent with well-known characteristics associated with the value/growth anomaly. However, predictable differences in investor and analyst expectations are *not* related to a firm's R&D activity.

Our analysis proceeds in three stages. First, we leverage the empirical design of Daniel and Titman (2006) and use realized log returns as a proxy for the total value-relevant information investors incorporate into price. We decompose realized log returns into two orthogonal components: an R&D return component ("R&D returns") and a non-R&D component ("non-R&D returns"). The advantage of this research design is that the R&D returns serve as an empirical proxy for the R&D information investors incorporate into stock price. More importantly, we have an orthogonal empirical proxy for all the value-relevant information other than R&D that investors incorporate into stock price. Our results suggest that both the level of R&D and changes in R&D are unrelated to future returns. Just as important, we show that non-R&D information, captured by our non-R&D returns variable, is strongly negatively associated with future returns.

Second, we investigate the effect that R&D investment has on the interpretation of current earnings by investors and the prediction of future earnings by analysts. We do this to further examine the "earnings fixation" explanation provided in prior studies. Our results suggest that investors interpret the current earnings of R&D firms similar to the earnings of non-R&D firms. Our evidence also suggests that analyst forecast errors are unrelated to R&D activity. Consistent with our results regarding future returns, forecast errors are attributable to non-R&D information, not R&D investment.

Finally, we examine the type of information captured in non-accounting variables such as non-R&D returns. Prior studies such as Daniel and Titman (2006) and Resutek (2010) refer to non-accounting returns as intangible returns but do not directly examine what value-relevant information they represent. We examine the composition of these non-accounting returns and show that they are positively associated with future asset growth, future earnings, and to a lesser extent, negatively associated with future earnings growth. These relations are slightly stronger in R&D firms than non-R&D firms. These results provide some economic intuition as to why R&D firms tend to realize higher future returns than non-R&D firms with similar characteristics and help map the R&D return anomaly into the broader value/growth anomaly.

Our study makes several contributions to the literature. First, we find that a firm's R&D investment is unrelated to future returns and analyst forecast errors. A relatively extensive literature examines the anomalous positive relation between R&D investment and future returns. While generally accepted accounting principles (GAAP) require the immediate expensing of R&D due to the uncertainty of future benefits and the difficulty in matching the expense with sales (SFAS No. 2 para. 39 and 49, Lev and Sougiannis 1996; Kothari et al. 2002), some studies suggest that immediate expensing of R&D misleads investors and causes mispricing (for example, Lev et al. 2005) and that managers should be given more discretion and opportunity to capitalize R&D investment.[1] Our findings suggest that while R&D is value-relevant to investors and analysts, the accounting treatment of R&D does not lead to systematic forecast errors.

Second, our study builds on Daniel and Titman (2006) and Resutek (2010), which show that the information investors incorporate into stock price that is not captured by accounting information (called intangible returns in each study) affects inferences between accounting metrics and future returns. However, neither study examines the relation between future earnings expectations and realized intangible returns. This relation is important to understand because forecast errors are often used to explain future returns. Our results suggest that investors and analysts make unbiased earnings projections based on current earnings and that the presence of R&D investment does not lead to predictable forecast biases. These results complement Daniel and Titman (2006) and Resutek (2010) by linking the properties of intangible returns to properties of earnings forecasts and earnings forecast errors.

Finally, our results help to tie the future returns of R&D firms into the larger value/growth literature. Lev and Sougiannis (1999), Chan et al. (2001), and Daniel and Titman (2006) each suggest that the value/growth anomaly is stronger in R&D firms, potentially indicating that R&D contributes to investor mispricing or shifts in firm risk. Our results suggest a slightly different interpretation. We find that R&D does not amplify the future returns of value and growth firms per se. Rather, the stronger future returns of R&D firms are associated with investors incorporating more value-relevant information into price that is not captured by R&D or summary accounting measures of growth.

Section 2 discusses prior literature and develops our research question. Section 3 describes our research design. Sections 4 and 5 discuss our primary empirical results and robustness tests. Section 6 provides concluding remarks.

2 Prior literature

Prior studies find that the level of R&D investment (generally referred to as R&D intensity in the literature) and growth in R&D investment are both positively associated with future returns (for example, Chan et al. 2001; Eberhart et al. 2004).

[1] In addition, the Securities and Exchange Commission has issued a roadmap to align GAAP with International Financial Reporting Standards (IFRS) in the near future. Conversion to IFRS-style standards would likely lead to more recognition of assets related to R&D activity because IFRS currently allows firms to capitalize a broader range of development costs.

Like many return anomalies involving accounting information, both risk and mispricing explanations have been offered.

With respect to a risk-based explanation, Chambers et al. (2002) find that, while firms exhibit consistently higher returns in event time, there is high variation of returns in calendar time. These results are consistent with risk explaining the future return pattern of R&D firms. Similarly, Lev and Sougiannis (1999) show that the book-to-market return reversal pattern is significantly stronger in R&D firms, consistent with risk characteristics associated with R&D activity affecting the risk characteristics of value/growth firms.[2]

The mispricing explanation for the relation between R&D activity and future returns relies on the hypothesis that investors fail to appreciate the positive implications of current R&D on future earnings. Specifically, investors underestimate future earnings because they do not understand that R&D costs incurred in the current period function more like an investment which produces future revenue rather than an expense (which is matched against current revenue). Then, investors reassess their earnings expectations in future periods when the benefits are unexpectedly realized, leading to a positive relation between future returns and current R&D (see Lev and Sougiannis 1996; Eberhart et al. 2004; Lev et al. 2005; Ali et al. 2009).[3]

Interestingly, there is little work linking the future return patterns associated with R&D investment to those associated with tangible, capitalized investment. This lack of research is curious because, while the accounting literature notes a *positive* relation between investment in R&D and future returns, a significantly larger number of studies in accounting and finance find a *negative* relation between future returns and tangible asset investment (for example, Sloan 1996; Titman et al. 2004; Cooper et al. 2008). This relation between tangible investments and future returns poses a puzzling question—why do two types of investment, both of which are linked to firm growth, produce opposite future return patterns?

Occam's razor suggests that there should be a common explanation for the future return patterns of both types of investment, whether it is a common firm characteristic, mispricing pattern, or risk factor shared across firms. However, many firm characteristics are associated with firm growth, investment, and future returns. Compounding the dilemma is the joint-hypothesis problem, which suggests that empirical tests of whether investors rationally incorporate information into stock price are joint tests of market efficiency and of the model for expected returns (Fama 1970).

Recent work in finance and accounting suggests an empirical design that may be useful in distilling the variation in future returns attributable to R&D from the

[2] In related work, Kothari et al. (2002) find that future earnings volatility is higher for R&D investments relative to capital expenditures, consistent with R&D increasing operating risk. Shi (2005) and Eberhart et al. (2008) examine the relation between R&D and risk to bondholders. Both find that R&D affects the inherent risk to bondholders, although they reach opposing conclusions as to whether R&D increases or decreases bondholder risk.

[3] In a related study, Penman and Zhang (2002) suggest that certain accounting mechanisms related to conservatism, including the immediate expensing of R&D, affect investors' assessments of future earnings in predictable manners.

variation explained by other value-relevant information. Specifically, Daniel and Titman (2006) assume that the realized return variation over a given period of time (for example, 1, 5 years, etc.) is a good proxy for the total value-relevant information investors incorporate into price over that period. Building on this assumption, they decompose realized returns into two primary components. The first component, termed the tangible return component, constitutes the component of total return over a given period of time that is explained by summary accounting return metrics (for example, change in book value, sales growth, etc.). The second component, termed the intangible return component, captures the component of total return unexplained by the summary accounting return metric. Daniel and Titman (2006) use this decomposition to show that the future return pattern associated with the value/growth anomaly is not due to investors mispricing long-horizon measures of accounting growth, as suggested by Lakonishok et al. (1994). Rather, Daniel and Titman (2006) suggest that the future return pattern that characterizes the value/growth anomaly is due to a negative relation between intangible return components and future returns. Resutek (2010) modifies the Daniel and Titman (2006) empirical design and provides evidence that the accrual anomaly (as short-term return reversal) can be viewed as a function of the value/growth anomaly and that prior period intangible returns explain the negative relation between current period accruals and future returns.

R&D firms have several characteristics suggesting that intangible returns could explain the return pattern associated with R&D investment. First, the payoff to R&D is uncertain both in timing and in substance. Building on the theoretical behavioral asset pricing literature, Daniel and Titman (2006) hypothesize, but do not test, that intangible returns could be positively related to a firm's R&D activity. Further, high R&D intensity firms tend to have recently experienced poor stock performance and low stock prices, similar to traditional value firms (for example, Chan et al. 2001).[4] Accordingly, it is possible that the positive association between R&D intensity and future returns is due to a *negative* association between intangible returns and future returns.

Ultimately, a carefully designed empirical test is required to distill the future return variation explained by R&D investment from that explained by other firm characteristics shared by R&D firms. In other words, because R&D activity is correlated with other accounting variables and firm characteristics that are also associated with future returns (particularly other forms of firm investment and growth), it is important to employ a research design that can effectively control for these joint correlations. As noted above and discussed in more detail below, by orthogonalizing the value-relevant information that investors incorporate into price that is related to R&D from that unrelated to R&D, we can make stronger inferences on the relation between future returns and R&D. These inferences are possible because we do not need to directly define each and every variable that is jointly correlated with future returns and R&D. Rather, we classify value-relevant

[4] Some studies attribute the poor stock performance to investors fixating on the negative impact of R&D on current earnings. However, as Daniel and Titman (2006) note, stock price can move for reasons unrelated to a firm's current earnings. For example, the approval or rejection of a pharmaceutical firm's drug patent could have a huge effect on the firm's stock price but would not affect its current earnings.

information as either related to R&D or unrelated to R&D. Further, because we use realized returns as our proxy for the total value-relevant information investors incorporate into price over a period, we can also control for information that is hard to empirically capture (for example, shifts in expectations of future earnings, asset growth, earnings growth, etc.) but known to be associated with future returns.

3 Research design

As noted above, we leverage the empirical design of Daniel and Titman (2006) and decompose realized returns, our proxy for total value-relevant information used by investors over a given period, into two components: an R&D component and a non-R&D component. The R&D component represents the value-relevant weight investors place on the R&D investments of a firm. In other words, if realized return variation maps strongly into R&D investment variation, then investors are placing a strong weight on the importance of R&D. Accordingly, the non-R&D component of realized returns represents the value-relevant weight investors place on all other information.

The following two logarithmic decompositions of R&D intensity (R&D scaled by current market value of equity, RDME_t) demonstrate the intuition behind our empirical design:

$$\log\left(\frac{\mathrm{RD}_t}{\mathrm{ME}_t}\right) = rdme_t = \log\left(\frac{\mathrm{RD}_{t-1}}{\mathrm{ME}_{t-1}}\right) + \Delta\log\left(\frac{\mathrm{RD}_{t-1,t}}{\mathrm{ME}_{t-1,t}}\right) \tag{1}$$

$$= \log\left(\frac{\mathrm{RD}_{t-1}}{\mathrm{ME}_{t-1}}\right) + \log\left(\frac{\mathrm{RD}_t}{\mathrm{RD}_{t-1}}\right) - \log\left(\frac{\mathrm{ME}_t}{\mathrm{ME}_{t-1}}\right) \tag{2}$$

Equation (1) shows that RDME_t can be expressed (logarithmically) as the sum of lagged R&D intensity plus a log change in R&D intensity. Equation (1) highlights that the positive association between RDME_t and future returns is due to either a positive association with (1) lagged R&D intensity, (2) the current change in R&D intensity, or (3) a combination of both elements. Prior studies confirm this assertion as each element has significant power in explaining future return variation (see Chan et al. 2001; Chambers et al. 2002).

However, Eq. (2) motivates our empirical design and offers an alternative interpretation of the positive association between current R&D intensity (RDME_t) and future returns. Equation (2) shows RDME_t as the logarithmic sum of lagged R&D intensity and R&D growth, *minus* change in market value of equity. If we hold constant the effect on market value of equity due to equity issuances/repurchases, we can interpret the change in market value of equity element as a measure of the aggregation of all new value-relevant information incorporated into stock price by investors over a given period of time. This value-relevant information includes information related to R&D investment and information unrelated to R&D investment (for example, cash flows, accruals, capital expenditures, changes in risk, changes in earnings expectations).

Expressing RDME_t as reflected in Eq. (2) demonstrates how the types of information captured by RDME_t explain future returns. Prior studies have shown that firms with high RDME_t values tend to have recently realized large negative returns and lower profitability (for example, Chan et al. 2001). Complementing this research, studies have shown that in subsequent periods, high R&D firms tend to realize higher profitability and higher future returns (for example, Eberhart et al. 2004). This stylized empirical fact leads to the interpretation that current R&D investment is mispriced by investors leading to higher future returns when this mispricing is corrected.

However, other firm characteristics, unrelated to a firm-specific R&D investment, could also explain the future returns. For example, if investors price the expected future earnings or future asset growth differently for R&D firms than non-R&D firms, then it is possible that R&D firms will have a distinct future return pattern from that of non-R&D firms. This pattern, however, may be unrelated to the firm's R&D investment. Nonetheless, it will be captured in RDME_t (and $\Delta\text{RDME}_{t-\tau,t}$), which are the primary variables used to measure a firm's R&D activity.

To examine this possibility, we leverage the logarithmic decomposition noted in Eq. (2) and decompose RDME_t into two distinct components: an R&D component and a non-R&D component. Specifically, by regressing future returns against elements of (2), we can distill from the components of RDME_t whether its relation with future returns is due to how investors view R&D investment, other firm characteristics captured by RDME_t, or a combination of both.

Before estimating these regressions, we need to transform the elements of (2) into log return variables that more closely resemble the information-based constructs that we describe above. We build from Daniel and Titman (2006), whose empirical design partitions realized returns into returns attributable to accounting performance measures, termed tangible returns, and returns attributable to non-accounting measures of performance, termed intangible returns. As noted above, we assume that a good measure of information about a firm is the total return for a dollar invested in the firm at the beginning of the period, or log market returns. For illustrative purposes, we show that the change in price over a given period can be transformed into the per share change in value over a given period (log return) as follows. Per the CRSP/Compustat data manual (see also Daniel and Titman 2006), the relation between log returns ($market\_return_{t-\tau,t}$) and log price changes can be expressed as follows:

$$\begin{aligned} market\_return_{t-\tau,t} &\equiv \sum_{s=t-\tau+1}^{t} \log\left(\frac{P_s \cdot f_s + D_s}{P_{s-1}}\right) \\ &= \sum_{s=t-\tau+1}^{t} \log\left(\frac{P_s}{P_{s-1}}\right) + \log(f_s) + \log\left(1 + \frac{D_s}{P_s \cdot f_s}\right) \\ &= \sum_{s=t-\tau+1}^{t} \log\left(\frac{P_s}{P_{s-1}}\right) + shradj\_fac, \end{aligned} \tag{3}$$

where f_s is the price adjustment factor due to stock splits and rights issues between $s-1$ and s; D_s is the value of all cash distributions paid between $s-1$ and s; P_s is the price per share at time s. Equation (3) shows that the log return over a given period of time is equal to the sum of log change in price, plus the log return earned from cash distributions to equity holders. From an economic intuition perspective, the importance of (3) is that it highlights that log returns are unaffected by changes in firm value due to equity issuances/repurchases and unaffected by stock splits and dividends. This is important because Daniel and Titman (2006) show that, while absolute growth measures are negatively associated with future returns, the negative relation is entirely due to growth associated with equity issuance/repurchase activity, not growth on a per-share basis.

Following Eq. (3), we transform the per share change in R&D expenditures over a period into a log return metric. Specifically, we compute a R&D return measure that captures the growth in R&D per dollar of equity invested at time $t - \tau$, $rd\_return_{t-\tau,t}$, as follows:[5]

$$rd\_return_{t-\tau,t} = \sum_{s=t-\tau+1}^{t} \log\left(\frac{\mathrm{RD}/share_s}{\mathrm{RD}/share_{s-1}}\right) + shradj\_fac.c \tag{4}$$

Similar to (3), Eq. (4) captures the per share change in R&D investment over a given period of time. However, distinct from prior studies examining R&D, $rd\_return_{t-\tau,t}$ measures growth in R&D adjusting for growth due to equity issuance/ repurchase activity. By measuring R&D changes on a per share basis, we can make cleaner inferences on the effect of organic R&D growth that are unrelated to R&D growth due to equity issuance. This distinction is important given the strong negative relation between net share issuance activity and future returns.

With growth in R&D now transformed into a log return scale, we substitute (3) and (4) into Eq. (2) and express log(RDME_t) as the following return-based identity:

$$\mathrm{Log}(\mathrm{RDME}_t) = rdme_t = rdme_{t-\tau} + rd\_return_{t-\tau,t} - market\_return_{t-\tau,t}. \tag{5}$$

Given that $market\_return_{t-\tau,t}$ (the log market return between $t-\tau$ and t) incorporates all value-relevant information investors incorporate into price between $t-\tau$ and t, it is important to separately distill the value-relevant information relating to R&D from that unrelated to R&D. We accomplish this by regressing $market\_return_{t-\tau,t}$ on the two other components of $rdme_t$ ($rdme_{t-\tau}$ and $rd\_return_{t-\tau,t}$). Specifically, to compute the value change from non-R&D information between $t-\tau$ and t, we annually regress the realized log market returns inclusive of dividends ($market\_return_{\mathrm{i},(t-\tau,t)}$), on lagged R&D intensity ($rdme_{i,t-\tau}$) and the measure of R&D returns described above ($rd\_return_{i,(t-\tau,t)}$):

$$market\_return_{i,(t-\tau,t)} = \gamma_0 + \gamma_1 rdme_{i,(t-\tau)} + \gamma_2 rd\_return_{i,(t-\tau,t)} + u_{i,t}. \tag{6}$$

From this regression, we derive two distinct components. The fitted value from the regression represents the portion of realized returns (or total value-relevant information) attributable to R&D investment (both level and change). The residual

[5] Note that the second element of $rd\_return_{t-\tau,t}$, $shradj\_fac$ is equal to the (log) number of shares one would have at time t, per shares held at time $t-\tau$, if one reinvested all cash distributions back into the stock. In other words, $shradj\_fac$ captures the effect of reinvesting cash dividends (and other cash distributions) back into shares of common stock.

represents the component of realized returns that is unrelated (orthogonal) to R&D. These residuals are defined as "non-R&D returns" ($nrd\_return_{t-\tau,t}$).[6] By construction, total log market return is equal to the sum of the log R&D returns *plus* the log non-R&D returns ($market\_return_{t-\tau,t} = rd\_return_{t-\tau,t} + nrd\_return_{t-\tau,t}$).

This empirical design provides several advantages. First, by partitioning total value-relevant information (as proxied by $market\_return_{t-\tau,t}$) into two orthogonal components representing the effects of R&D investment and non-R&D information on price, we avoid concerns that significant (or insignificant) associations between future returns and our explanatory variables are the result of omitted correlated variables.

Second, the advantage of using $rd\_return_{t-\tau,t}$ as a measure of R&D growth as opposed to using a measure of total growth in R&D (for example, $\Delta\log(\text{R\&D})_{t-\tau,t}$) is that $rd\_return_{t-\tau,t}$ captures growth in R&D spending per dollar of equity invested at time $t-\tau$. For example, consider a R&D firm that initiates a seasoned equity offering between $t-1$ and t and doubles the number of common shares outstanding. With the equity infusion it receives, it subsequently doubles its R&D spending. Total growth in R&D between $t-1$ and t would be 100%. However, growth in R&D for an investor invested at $t-1$, measured by $rd\_return_{t-1,t}$ would be zero, as the log change in R&D per share would be zero (in other words, the growth in R&D was due to new investment from new equity, not existing equity). Thus, our research design minimizes concern that any relation between future returns and change in R&D is driven by equity issuance activity.[7]

Third, although our empirical design uses components from a scaled variable (RDME_t), the components derived from the decomposition and used as explanatory variables are returns-based. This transformation reduces the distortive effect on inferences due to biases related to the manner in which accounting variables are scaled. Scale-related biases can lead to attenuated standard errors due to heteroskedasticity and coefficient bias (Barth and Kallapur 1996). While Barth and Kallapur (1996) suggest including a scale variable in the regression as an additional control, this solution is problematic in the R&D setting where a vast literature exists relating R&D investment efficiency to firm scale (for example, Cohen and Klepper 1996).[8] Ultimately, it is unlikely that any proxy could control perfectly for scale differences across firms independent of the level of R&D investment.

[6] The use of the term "intangible" by Daniel and Titman (2006) and Resutek (2010) refers to non-accounting information. Because this concept is related to the "intangible" nature of R&D assets, we generally avoid the term "intangible returns" and instead utilize "non-R&D Returns" to avoid ambiguity or confusion when we examine returns correlated with reported R&D.

[7] The same intuition holds, in reverse, for firms who repurchase outstanding shares.

[8] In addition, standard accounting scale measures such as earnings and book value are biased for R&D firms (for example, Lev et al. 2005). This is particularly problematic given that the extent of bias is related to the efficiency of investment because more efficient R&D investment will create a higher level of unrecognized assets. In turn, R&D investment efficiency is related to firm scale (see, for example, Cohen and Klepper 1996).

4 Empirical analysis

4.1 Sample selection and data description

Our primary sample period includes firms with fiscal year-ends between January 1973 and December 2008. To be included in the sample, firms must appear in the Compustat database and have positive R&D expenditures in years t and $t-1$. This yields a primary sample of roughly 1,600 firms per year (see Panel A of Table 1 for detailed sample construction). Future return computations span between July of year $t+1$ and June of year $t+2$ for all firms with fiscal year-ends between April–December of year t, January–March of year $t+1$. Monthly returns are from CRSP. All other variables are computed from Compustat. All accounting variables (for example, R&D scaled by market equity, RDME_t) are annually winsorized at the 1st and 99th percentiles.

4.2 Descriptive statistics

Panels B and C of Table 1 report descriptive statistics of our primary sample. Consistent with cross-sectional properties of the Fama and MacBeth (1973) regressions and portfolio analysis reported in later tables, panels B and C report time-series means of the annual descriptive statistics. Panel B of Table 1 presents summary statistics for the full sample. The results are largely consistent with prior studies, but certain firm characteristics are worth noting. First, R&D firms have smaller market capitalizations. Further, consistent with the conjecture of Daniel and Titman (2006) that R&D investment could be related to their measure of intangible returns, panel B shows that most of the firms in this sample can be classified as growth firms (book-to-market <1.0). Given the strong negative relation between future returns and growth firms (Lakonishok et al. 1994; Fama and French 1995), this suggests that the positive relation between R&D firms and future returns is not a direct transformation of the value/growth anomaly. Finally, while the average firm in our sample is increasing its R&D investment level (both on a total and per share basis), there is a considerable number of firms reducing their R&D investment levels.

Panel C reports a correlation matrix for key variables and provides suggestive evidence that other information captured by R&D intensity measures or correlated with R&D growth may be responsible for the future return patterns attributed to R&D firms. First, there is a strong negative association ($\rho = -0.33$) between current R&D intensity ($rdme_t$) and the most recent 1-year realized stock return, implying that firms classified as high (low) R&D intensity firms tend to have just realized low (high) market returns, consistent with Chan et al. (2001). Second, there is a stronger negative relation between $rdme_t$ and $nrd\_return_{t-1,t}$ (−0.42) than the positive relation between $rdme_t$ and $rd\_return_{t-1,t}$ (0.09). These relations suggest that information incorporated into stock price over the past year that is unrelated to R&D has a much more significant effect on $rdme_t$ than the effect of R&D. Finally, the most recent 1-year realized stock return is positively associated with the R&D

Table 1 Summary statistics

Panel A: Sample construction

Compustat firms with 12 monthly returns between $t-1$ and t and f/y/e between 1/73–12/08	183,707
Primary sample	
All firms with share code 10 or 11, exchange code between 1 and 3, non-missing R&D in fiscal years t and $t-1$, fiscal year-end between 1/31/73–12/31/08, and valid price as of June 30, $t+1$	56,145
Supplemental sample	
All firms with share code 10 or 11, exchange code between 1 and 3, positive book value at fiscal yearend t and $t-1$, fiscal year-end between 1/31/73–12/31/08, and valid price as of June 30, $t+1$	142,039

Panel B: Summary statistics

	Mean	Median	SD	Q25	Q75	Min.	Max.	Nobs.
BM_t	0.728	0.615	0.586	0.339	0.985	(0.618)	2.967	1,603.2
ME	1,678.29	117.21	8,809.63	31.82	514.68	0.78	182,960.38	1,604.1
Price	17.331	11.219	18.942	4.739	23.672	0.144	227.430	1,604.1
$RDME_t$	0.085	0.046	0.112	0.019	0.102	0.001	0.673	1,604.1
RD $Growth_{t-1,t}$	0.224	0.103	0.644	(0.055)	0.316	(0.749)	4.008	1,604.1
$rd\_return_{t-1,t}$	0.070	0.092	0.438	(0.086)	0.253	(1.558)	1.494	1,604.1
$nrd\_return_{t-1,t}$	0.002	0.036	0.517	(0.295)	0.321	(1.473)	1.309	1,604.1
$\Delta RDME_{t-1,t}$	0.010	0.002	0.089	(0.012)	0.023	(0.279)	0.428	1,604.1

Panel C: Pearson (Spearman) correlation coefficients reported above (below) the diagonal

	$rdme_t$	$rdme_{t-1}$	RD $Growth_{t-1,t}$	$\Delta RDME_{t-1,t}$	$rd\_return_{t-1,t}$	$nrd\_return_{t-1,t}$	$market\_return_{t-1,t}$
$rdme_t$	1.00	0.82	0.02	0.27	0.09	(0.42)	(0.33)
$rdme_{t-1}$	0.83	1.00	(0.29)	(0.11)	(0.29)	0.00	0.09
RD $Growth_{t-1,t}$	0.01	(0.25)	1.00	0.24	0.83	0.01	0.03
$\Delta RDME_{t-1,t}$	0.31	(0.15)	0.38	1.00	0.32	(0.58)	(0.60)
$rd\_return_{t-1,t}$	0.00	(0.29)	0.92	0.43	1.00	0.00	0.04
$nrd\_return_{t-1,t}$	(0.41)	(0.02)	0.03	(0.70)	0.01	1.00	0.96
$market\_return_{t-1,t}$	(0.32)	0.08	0.05	(0.72)	0.03	0.96	1.00

Above table reports the sample construction (in Panel A) and summary descriptive statistics (in Panel B) for the primary sample of firm year observations for firms with fiscal years ending t (1/31/73–12/31/08). Panel C reports Pearson (Spearman) correlation coefficients of relevant variables above (below) the diagonal for the primary sample. BM_t is the book-to-market ratio computed as book value of common equity as of fiscal year-end scaled by market value of equity as of fiscal year-end. To compute book equity we take, when not missing, shareholder's equity (SEQ), or common equity plus preferred stock (CEQ + PSTK), or total assets minus total liabilities (AT-LT), in that order. From shareholders equity, we subtract preferred stock value, where we use either redemption value (PSTKRV) or liquidating value (PSTKL), in that order. Finally, if not missing we add to book value the balance sheet value of deferred taxes. *ME* is equal to market value of equity as of $6/30/t+1$. *Price* is equal to the price per share as of $6/30/t+1$ per CRSP. $RDME_t$ is equal to R&D expense scaled by market value of equity as of fiscal year-end. $rdme_t$ is the natural logarithm of $RDME_t$. *RD* $Growth_{t-1,t}$ is equal to one year growth in R&D expense. $rd\_return_{t-1,t}$ is equal to the log change in R&D per share between $t-1$ and t plus the share adjustment factor (shradj_fac). $nrd\_return_{t-1,t}$ is the non-R&D return between $t-1$ and t defined as the residual from annual regressions of log market return, $market\_return_{t-1,t}$, on $rdme_{t-1}$ and $rd\_return_{t-1,t}$. $\Delta RDME_{t-1,t}$ equals $RDME_t$–$RDME_{t-1}$. $market\_return_{t-1,t}$ is equal to the 1-year raw, buy-and-hold log return (inclusive of dividends) between fiscal year-end $t-1$ and t

growth over the same period. This implies that R&D is viewed positively by investors and not negatively as prior studies suggest.

In summary, these correlations provide suggestive evidence that the positive relation between $rdme_t$ and future returns may be due to information captured in $rdme_t$ that is unrelated to R&D investment. Subsequent analysis uses regression analysis and portfolio sorts to examine the relation between R&D investment and future returns in a multivariate setting that controls for firm characteristics that are jointly correlated with R&D and future returns.

4.3 Regression analysis

Panel C of Table 1 reflects a high correlation between current and lagged R&D intensity measures (for $rdme_t$ with $rdme_{t-1}$, $\rho = 0.82$), suggesting that R&D intensity is very persistent. Also, the correlations suggest that R&D intensity may explain more future return variation than changes in R&D investment. However, as discussed above, measures of R&D intensity are jointly affected by R&D investment and other firm characteristics. Accordingly, we turn to regression analysis to distill the future return variation explained by R&D.

We use the log-linear return components derived from $rdme_t$ as our proxies for the information investors incorporate into price related to (1) the level of R&D investment ($rdme_{t-\tau}$), (2) the per share change in R&D investment ($rd\_return_{t-\tau,t}$), and (3) all other information that is unrelated to R&D but incorporated into price ($nrd\_return_{t-\tau,t}$) (see Sect. 3 for detailed discussion of the construction and interpretation of these variables).

We employ Fama and MacBeth (1973) regressions of future monthly returns on the log-linear return components of $rdme_t$. The null hypothesis is that consistent with efficient markets, risk-neutral investors, and rational expectations, realized return variation explained by level of R&D investment and change in R&D investment should be unrelated to future returns. However, if future return variation is explained by the lagged level or current change in R&D investment, both publicly available accounting variables, the null hypothesis can be rejected.

Panel A of Table 2 reports the average slope coefficients and time-series mean *t* statistics from annual regressions of log market return ($market\_return_{t-\tau,t}$) on the log-linear return components of $rdme_t$. If R&D information is value-relevant, we expect significant coefficients on the R&D components of $rdme_t$ ($rdme_{t-\tau}$, $rd\_return_{t-\tau,t}$). Consistent with this intuition, panel A shows that both measures of lagged R&D intensity and both measures of per share growth in R&D ($rd\_return_{t-\tau,t}$) are positively associated with the log market return over the respective periods. Interestingly, the per share growth in R&D is *positively* associated with contemporaneous returns. Prior studies suggest that investors view current R&D expenditures negatively and bid stock price down. The positive slopes on $rdme_{t-\tau}$ and $rd\_return_{t-\tau,t}$ suggest that investors view R&D positively. We investigate this result more formally in Table 6.

Panels B and C of Table 2 reports the results from our regression analysis for all firms (panel B) and firms with share price greater than or equal to \$5/share as of

Table 2 Regressions of stock returns on log-linear return components of $RDME_t$

Reg.	Int.	$rdme_{t-1}$	$rd\_return_{t-1,t}$	$rdme_{t-5}$	$rd\_return_{t-5,t}$	Adj. R^2 (%)
Panel A: Construction of non-R&D returns						
	Dependent variable: $market\_return_{t-1,t}$					
1	0.130	0.046	0.076			2.53
	(2.20)	(4.65)	(8.78)			
	Dependent variable: $market\_return_{t-5,t}$					
2	0.930			0.258	0.491	20.73
	(10.37)			(15.38)	(24.11)	

Reg.	Int.	$rdme_t$	$rdme_{t-1}$	$rd\_return_{t-1,t}$	$market\_return_{t-1,t}$	$nrd\_return_{t-1,t}$	$nrd\_return_{t-5,t}$	Adj. R^2 (%)
Panel B: Dependent variable = future monthly returns (all firms)								
1	2.923	0.411						0.52
	(5.82)	(6.12)						
2	2.726		0.328	0.116				0.52
	(5.52)		(5.29)	(1.09)				
3	2.741		0.355	0.192	−0.627			1.12
	(5.73)		(5.74)	(1.87)	(−4.12)			
4	2.744		0.330	0.111		−0.651		1.13
	(5.54)		(5.31)	(1.05)		(−4.13)		
5	1.886		0.092	−0.056			−0.356	1.31
	(3.73)		(1.19)	(−0.39)			(−3.18)	
6	1.578			−0.102			−0.431	0.84
	(4.52)			(−0.71)			(−4.16)	
Panel C: Dependent variable = future monthly returns (share price ≥ $5)								
1	2.154	0.240						0.50
	(4.96)	(4.61)						
2	2.039		0.207	0.134				0.69
	(4.56)		(3.67)	(1.25)				
3	2.139		0.226	0.151	−0.237			1.23
	(4.95)		(4.08)	(1.42)	(−1.91)			
4	2.110		0.214	0.115		−0.233		1.23
	(4.68)		(3.75)	(1.09)		(−1.83)		
5	1.740		0.121	0.056			−0.094	1.27
	(3.41)		(1.48)	(0.47)			(−1.02)	
6	1.380			0.002			−0.203	0.52
	(4.25)			(0.02)			(−2.85)	

Panel A reports the results of Fama–MacBeth regressions utilized to construct non-R&D returns (*nrd_return*). In regression 1 (2), $market\_return_{t-1,t}$ ($market\_return_{t-5,t}$) is regressed on $rdme_{t-1}$ and $rd\_return_{t-1,t}$ ($rdme_{t-5}$ and $rd\_return_{t-5,t}$). Panels B and C report the results of a set of Fama–MacBeth regressions of monthly returns on components of the log-linear return decomposition of the R&D-to-market ratio at fiscal year-end t. Panel B reports results for all firms, while Panel C includes only firms with share prices ≥$5 on June 30, $t+1$. The monthly return series is between July of year $t+1$ and June of year $t+2$ for all firms with fiscal year-ends between April–December of year t, January–March of year $t+1$ for fiscal years ending 1/73–12/08. All coefficients are multiplied by 100. t-statistics are reported in parentheses. $rdme_t$ is log R&D-to-market value of equity as of fiscal year-end t. $rd\_return_{t-1,t}$ is equal to the log change in R&D per share between $t-1$ and t. $market\_return_{t-1,t}$ is equal to the log market return (inclusive of dividends) between $t-1$ and t. $nrd\_return_{t-1,t}$ is the non-R&D component of log return between $t-1$ and t defined as the residual from annual regressions of log market return, $market\_return_{t-1,t}$, on $rdme_{t-1}$ and $rd\_return_{t-1,t}$. $nrd\_return_{t-5,t}$ is the non-R&D component of log return between $t-5$ and t defined as the residual from annual regressions of log market return, $market\_return_{t-5,t}$, on $rdme_{t-5}$ and $rd\_return_{t-5,t}$

June 30, $t + 1$ (panel C). Regression 1 in each panel establishes the economically significant relation between future monthly returns and R&D intensity as measured by $rdme_t$. Regression 2 examines the relation of future monthly returns with $rdme_{t-1}$ and $rd\_return_{t-1,t}$. Interestingly, regression 2 suggests that per share growth in R&D ($rd\_return_{t-1,t}$) is not associated with future returns once beginning of period R&D intensity is controlled, suggestive that the *level* of R&D investment is more strongly associated with future returns than the *change* in R&D investment. Regression 3 completes the 1-year log-linear return decomposition of $rdme_t$. Regression 3 suggests that $rdme_t$ forecasts future returns due to information captured in lagged R&D intensity ($rdme_{t-1}$) and lagged 1-year market return ($market\_return_{t-1,t}$), while per share change in R&D does not explain future return variation.

Note that because $market\_return_{t-1,t}$ contains all value-relevant information investors incorporate into price between $t - 1$ and t, including R&D investment information ($rd\_return_{t-1,t}$), multicollinearity could attenuate the significance of coefficients on the R&D components. Regression 4 solves this problem by substituting for $market\_return_{t-1,t}$ the variable $nrd\_return_{t-1,t}$. As detailed above, $nrd\_return_{t-1,t}$ represents the component of $market\_return_{t-1,t}$ that is orthogonal to the level and change in R&D investment. Thus, from an econometric perspective, we can measure the incremental relation between future returns and all other non-R&D value-relevant information investors incorporate into stock price without concern of possible multicollinearity across control variables affecting inferences.

Regression 4 suggests that the significant relation between future returns and $rdme_t$ is due to a combination of a positive relation between lagged R&D intensity with future returns and a negative relation between $nrd\_return_{t-1,t}$ with future returns.[9] The positive and significant relation between $rdme_{t-1}$ and future returns suggests three possible explanations for future returns: R&D investments made prior to $t - 1$, other non-R&D information incorporated into price prior to $t - 1$ and captured in $rdme_{t-1}$, or a combination of the two.

To determine what explains the significant relation between future returns and $rdme_{t-1}$, we examine regression 5, which is identical to regression 4 except that we substitute $nrd\_return_{t-5,t}$ for $nrd\_return_{t-1,t}$. If the positive relation between $rdme_{t-1}$ and future returns noted in regression 4 is due to information investors incorporate into price that is *unrelated* to R&D investment between $t - 5$ and $t - 1$, then $rdme_{t-1}$ should be unrelated to future returns once $nrd\_return_{t-5,t}$ is controlled. However, if the positive association between future returns and $rdme_{t-1}$ is due to R&D investments made between $t - 5$ and $t - 1$, then $rdme_{t-1}$ should still be positively associated with future returns after controlling for $nrd\_return_{t-5,t}$. Consistent with the former idea, regression 5 shows that $nrd\_return_{t-5,t}$ subsumes the explanatory power of $rdme_{t-1}$. Specifically, regression 5 notes an insignificant relation between future returns and both R&D components ($rdme_{t-1}$, $rd\_return_{t-1,t}$) while a strong negative relation is noted with $nrd\_return_{t-5,t}$. Inferences from regression 5 suggest that the significant relation between $rdme_{t-1}$ and future returns

[9] Even though $nrd\_return_{t-1,t}$ is orthogonal to $rdme_{t-1}$ and $rd\_return_{t-1,t}$, the coefficients on these variables are slightly different between (2) and (4) because we do not require that a full set of 12 future monthly returns to exist to be included in our sample. Accordingly, since some of the firms used to compute $nrd\_return_{t-1,t}$ do not have a complete set of 12 future returns, the coefficients change slightly.

noted in regression 4 is due to value-relevant information investors incorporate into stock price between $t-5$ and t that is unrelated to R&D investment information. Finally, regression 6 shows that $nrd\_return_{t-5,t}$ is strongly associated with future returns in both panel B and panel C. The weaker relation between future returns and $nrd\_return_{t-5,t}$ noted in regression 5 is due to the fact that $rdme_{t-1}$ and $nrd\_return_{t-5,t}$ are highly correlated.

The results in Table 2 suggest that there is no significant relation between future return variation and a firm's R&D activity. Rather, the positive relation between R&D activity and future returns documented in prior studies is due to firm characteristics unrelated to the firm's R&D activity but present in R&D firms. These characteristics are captured in our proxy for non-R&D information, $nrd\_return_{t-\tau,t}$.

While this explanation may at first appear circular, the intuition is very simple. A combination of firm characteristics, risk factor exposures, or mispricing captured by $nrd\_return_{t-\tau,t}$ is responsible for the seemingly positive relation between R&D activity and future returns. Since $nrd\_return_{t-\tau,t}$ is unrelated to R&D activity *by construction* and increases or decreases in R&D activity are unrelated to future return variation, this implies that changes in R&D investment do not affect firm risk and changes in R&D are not mispriced by investors. Rather, the coefficients reported in Table 2 imply that other non-R&D firm characteristics that are present in R&D firms are mispriced or are associated with firm risk. It is these other characteristics captured by $nrd\_return_{t-\tau,t}$, not R&D, that explain future returns.

Admittedly, explaining the R&D anomaly as a derivative of another anomaly using a variable that is defined by what it is not is somewhat unsatisfying. We examine these issues further in later analysis (Table 6) and attempt to place some structure to the composition of the $nrd\_return_{t-\tau,t}$ variable.

4.4 Portfolio tests

Table 3 reports the results of non-parametric portfolio sorts. The purpose of these non-parametric tests is to address possible concerns that a non-linear relation between changes in R&D and future returns leads to the insignificant association we document. Panels A and C report the results of annual sorts of firms into quintiles based the level of R&D intensity (RDME_t) and on the 1-year change in R&D intensity ($\Delta\text{RDME}_{t-1,t}$) respectively. These panels serve to establish the statistical and economic significance of the future return variation explained by these variables and to provide benchmark hedge returns to compare with prior studies.

Consistent with the tenor of prior studies, panel A reports an economically and statistically significant hedge return earned by taking long (short) positions in firms with high (low) RDME_t values. The average monthly hedge return is more than 1.1%, yielding an economically significant annual hedge return of more than 13%.

Panel A shows that sorting firms into quintiles based on RDME_t also sorts firms into quintiles based on growth in non-R&D ($nrd\_return_{t-5,t}$) elements. Since $nrd\_return_{t-5,t}$ explains significant future return variation, panel B controls for $nrd\_return_{t-5,t}$ while maximizing the dispersion in the variable of interest, RDME_t. Specifically, we annually sort firms into percentiles based on $nrd\_return_{t-5,t}$. We

Table 3 Portfolio sorts of $RDME_t$, $\Delta RDME_{t-5,t}$, and $nrd\_return_{t-\tau,t}$

	Q1	Q2	Q3	Q4	Q5	Ret diff. (%)	FM t
Panel A: Annual sorts on $RDME_t$							
$RDME_t$	0.009	0.026	0.048	0.088	0.245		
$nrd\_return_{t-5,t}$	0.846	0.356	0.045	(0.294)	(0.947)		
Avg. monthly $return_{t,t+1}$ (all)	1.06%	1.33%	1.50%	1.71%	2.24%	1.18	(4.14)
Panel B: Annual sorts on $RDME_t$*, controlling for* $nrd\_return_{t-5,t}$							
$RDME_t$	0.032	0.058	0.086	0.116	0.175		
$nrd\_return_{t-5,t}$	(0.007)	(0.018)	(0.029)	0.000	0.010		
Avg. monthly $return_{t,t+1}$ (all)	1.42%	1.50%	1.52%	1.68%	1.78%	0.36	(1.89)
Panel C: Annual sorts on $\Delta RDME_{t-1,t}$							
$\Delta RDME_{t-1,t}$	(0.077)	−0.010	0.001	0.0142	0.104		
$nrd\_return_{t-1,t}$	0.417	0.278	0.124	−0.112	−0.509		
Avg. monthly $return_{t,t+1}$ (all)	1.60%	1.30%	1.31%	1.45%	2.16%	0.56	(3.12)
Panel D: Annual sorts on $\Delta RDME_{t-1,t}$*, controlling for* $nrd\_return_{t-1,t}$							
$\Delta RDME_{t-1,t}$	(0.048)	(0.003)	0.018	0.035	0.063		
$nrd\_return_{t-1,t}$	(0.179)	0.075	0.107	0.066	(0.072)		
Avg. monthly $return_{t,t+1}$ (all)	1.59%	1.54%	1.47%	1.60%	1.61%	0.03	(0.16)

Above table reports the results of annual portfolio sorts based on the R&D characteristics of the sample firms. Panels A and C report the average of firm characteristics and monthly returns for quintiles formed from annual sorts based on $RDME_t$ and $\Delta RDME_{t-1,t}$ respectively. All variables are defined the same as in prior tables. All characteristic averages represent Fama–Macbeth averages (an average of annual averages). Hedge returns represent the hypothetical monthly return from taking a long (short) position in firms classified in Q5 (Q1)

Panels B and D report the results of annual portfolio sorts based on $RDME_t$ and $\Delta RDME_{t-5,t}$ controlling for $nrd\_return_{t-5,t}$ and $nrd\_return_{t-1,t}$ respectively. To maximize the variation in the variable of interest, while minimizing the variation in $nrd\_return_{t-\tau,t}$, we perform a series of dependent sorts. At the end of June in each year, we sort all firms into annual percentiles ranked on $nrd\_return_{t-\tau,t}$. Each of these annual $nrd\_return_{t-\tau,t}$ deciles is then sorted into annual quintiles based on $RDME_t$ (Panel B) and $\Delta RDME_{t-1,t}$ (Panel D). We then pool the quintiles across years, thereby maximizing dispersion in $RDME_t$ and $\Delta RDME_{t-1,t}$ (Panels B and D respectively), while minimizing the dispersion in $nrd\_return_{t-\tau,t}$

then sort these annual percentiles into quintiles based on $RDME_t$. Annual quintiles are then aggregated, thereby maximizing dispersion in $RDME_t$ while minimizing dispersion in $nrd\_return_{t-5,t}$. Panel B reports the results of this analysis. Interestingly, there is a marginally significant relation between $RDME_t$ and future returns after controlling for $nrd\_return_{t-5,t}$ in the full sample. This said, differences in the economic and statistical significance in the hedge returns reported across panels A and B essentially confirm that the R&D investments made by firms are unrelated to future returns.

Panel C sorts firms into annual quintiles based on the 1-year change in R&D intensity, proxied for by $\Delta RDME_{t-1,t}$. Consistent with the tenor of Chambers et al. (2002), monthly hedge returns realized from taking hypothetical long (short) positions in high (low) $\Delta RDME_{t-1,t}$ firms is an economically significant 0.56% per month. However, sorts on $\Delta RDME_{t-1,t}$ jointly produces variation in not just $\Delta RDME_{t-1,t}$ but also $nrd\_return_{t-1,t}$. Accordingly, using the same empirical portfolio design of panel B, in panel D we control for $nrd\_return_{t-1,t}$ while maximizing dispersion in $\Delta RDME_{t-1,t}$. Consistent with the tenor of prior tables, panel D shows that the power of $\Delta RDME_{t-1,t}$ to forecast future returns is unrelated to R&D investment of the firms. Rather, the relation between future returns and $\Delta RDME_{t-1,t}$ is due to firm characteristics shared by R&D firms (and measured by $nrd\_return_{t-1,t}$) that are unrelated to R&D activity.[10]

5 Earnings, R&D, and intangible returns

In Sect. 4, we examined the relation between the R&D and non-R&D components of realized returns and future returns. Our empirical evidence suggests that while R&D firms may earn higher future returns than non-R&D firms, this pattern is unrelated to both the level and the change in R&D investment. Instead, our empirical evidence suggests that the positive future returns associated with R&D by prior studies are actually due to the non-R&D information investors incorporate into price (labeled $nrd\_return_{t-\tau,t}$ in the prior section).

In this section, we examine the effect that R&D and non-R&D return components have on the future earnings expectations of investors and analysts. We are interested in understanding these relations for two reasons. First, prior studies (for example, Lev et al. 2005) have coupled a strong positive relation between current period R&D investment and future profitability with the strong positive association between current period R&D and future returns as evidence that investors misprice the current earnings of R&D firms, leading to positive future returns. An alternative explanation for the relation noted in prior studies is that $nrd\_return_{t-\tau,t}$, the information that investors incorporate into price that is unrelated to R&D, is also positively associated with future earnings. Accordingly, it could be the information contained in $nrd\_return_{t-\tau,t}$ and captured by R&D intensity measures, not R&D, that biases future earnings estimates. We examine this in Sect. 5.1.

Second, an alternative interpretation of our results and those of prior R&D studies is that R&D distorts earnings and therefore mechanically weakens the relation between accounting-based performance measures such as earnings and future returns. That is, if R&D distorts earnings, it essentially adds noise to earnings as a performance measure. From an econometric perspective, a noisy explanatory variable will mechanically cause the error term in any regression to explain a larger percentage of the dependent variable. For purposes of our empirical design, this would mean that log book return would explain a smaller percentage of total log market return ($market\_return_{t-\tau,t}$) for R&D firms relative to non-R&D firms. If investors systematically underweight the log book return of R&D firms relative to non-R&D firms, this might explain why prior studies such as Penman and Zhang (2002) find that controlling for the conservative nature of accounting for R&D helps

[10] For brevity, we do not report portfolio results for firms trading at more than \$5/share (with portfolio breakpoints determined using only firms with share prices greater than \$5). Results are qualitatively identical to those reported in Table 3.

explain future earnings of R&D firms even after controlling for current earnings. We examine this possibility more closely in Sect. 5.2.

5.1 The relation between R&D activity and analyst forecast errors

Table 4 directly examines the relation between analyst forecast errors in $t + 1$ and the log-linear return components of $rdme_t$. The purpose of the regressions in Table 4 is to determine whether errors in analyst earnings expectations that prior studies have attributed to R&D are actually due to the value-relevant information captured by $nrd\_return_{t-\tau,t}$. For example, if analysts underestimate the positive implications of current R&D investment on future profitability, as suggested in prior studies, we should see a significant *positive* relation between our R&D variables ($rdme_{t-\tau}$, $rd\_return_{t-\tau,t}$) and analyst forecast errors. If, however, analyst forecasts are affected by $nrd\_return_{t-\tau,t}$ and not by R&D investment, as our prior tables suggest, we should see a significant *negative* relation between analyst forecast errors and $nrd\_return_{t-\tau,t}$ and insignificant relations with our R&D variables.[11] Thus, Table 4 serves as a direct test of earnings fixation as an explanation for the positive association of current period R&D and future returns.

We measure analyst forecast errors as follows. We compute the consensus analyst forecast error as the mean analyst forecast for year $t + 1$ as of the sixth month of year $t + 1$. For example, for a firm with a calendar fiscal year, we compute the consensus forecast for year $t + 1$ at the end of June, $t + 1$. Analyst forecast errors are computed as actual earnings per share (as reported by I/B/E/S) minus the consensus earnings forecast as of the sixth month. Forecast variables are scaled by price as of the beginning of the fiscal year. To minimize the distortive effects of extreme observations, we trim all observations with unexpected earnings greater than/less than 5% of market value of equity.

Regressions 1 through 3 examine the relation between $rdme_t$, its 1-year log-linear return components, and analyst forecast errors. Results are largely in line with the tenor of earlier results. Lagged R&D intensity ($rdme_{t-1}$) is strongly associated with forecast errors, while per share change in R&D ($rd\_return_{t-1,t}$) is unrelated to forecast errors. Interestingly, $nrd\_return_{t-1,t}$ is unrelated to analyst forecast errors and the coefficient is positive.

Regressions 4 and 5 examine the relation between analyst forecast errors and the 5-year log-linear return components of $rdme_t$. Similar to Table 2, regressions 4 and 5 examine the relation between the components of a 5-year decomposition of $rdme_t$ and analyst forecast errors to see if the positive relation between analyst forecast errors and $rdme_{t-1}$ is due to prior period R&D activity ($rd\_return_{t-5,t-1}$, and

[11] Prior research finds mixed results regarding the relation between analyst forecast errors and R&D. Thomas (2002) finds a generally positive relation between R&D scaled by sales and forecast errors, but the relation becomes negative when return volatility is controlled. Kothari et al. (2002), however, note that controlling for volatility may take away the "treatment effect" of R&D. Chambers et al. (2002) find a negative relation between R&D scaled by assets and forecast errors. Barron et al. (2002) find greater dispersion in forecast errors for firms with high R&D investment, measured as R&D expense scaled by total expense.

Table 4 Analyst forecast errors

Reg.	Int.	$rdme_t$	$rdme_{t-1}$	$rdme_{t-5}$	$rd\_return_{t-5,t-1}$	$rd\_return_{t-1,t}$	$nrd\_return_{t-5,t-1}$	$nrd\_return_{t-1,t}$
Panel A: Regressions of analyst forecast errors on components of $RDME_t$ (all firms)								
1	−0.246	0.046						
	(−2.56)	(2.30)						
2	−0.185		0.063			−0.026		
	(−2.28)		(3.46)					
3	−0.185		0.063			−0.026		0.075
	(−2.28)		(3.47)			(−0.50)		(1.55)
4	−0.308		0.024		−0.026	0.007	−0.068	0.098
	(−2.73)		(0.92)		(−0.98)	(0.12)	(−1.76)	(1.29)
5	−0.421			−0.010	−0.028	−0.001	−0.091	0.094
	(−5.09)			(−0.50)	(−0.95)	(−0.02)	(−3.61)	(1.22)
Panel B: Regressions of analyst forecast errors on components of $RDME_t$ (Price ≥ $5)								
1	−0.342	0.017						
	(−3.86)	(0.94)						
2	−0.227		0.048			−0.047		
	(−2.96)		(2.63)			(−1.00)		
3	−0.235		0.048			−0.043		0.165
	(−3.06)		(2.61)			(−0.93)		(3.76)
4	−0.361		0.009		−0.023	−0.019	−0.074	0.165
	(−3.54)		(0.36)		(−0.96)	(−0.32)	(−1.91)	(2.13)
5	−0.459			−0.021	−0.033	−0.027	−0.084	0.161
	(−6.09)			(−1.00)	(−1.14)	(−0.45)	(−3.21)	(2.06)

Above table reports the results of regressions of analyst forecast errors on components of the log-linear return decomposition of the R&D-to-market ratio at fiscal year-end t. Panel A reports results for all firms, while Panel B includes only firms with share prices ≥ $5 as of June 30, $t + 1$. All variables except analyst forecast errors are as defined earlier. We compute the consensus analyst forecast error as the mean analyst forecast for year $t + 1$ as of the sixth month of year $t + 1$. Analyst forecast errors are computed as actual earnings per share (as reported by I/B/E/S) minus the consensus earnings forecast as of the sixth month. Forecast variables are scaled by price as of the beginning of fiscal year t. To minimize the distortive effects of extreme observations, we trim all observations with unexpected earnings greater than 5% of market value of equity. All coefficients are multiplied by 100. t statistics are reported in parentheses with standard errors clustered by firm and year

$rd\_return_{t-1,t}$) or from prior-period non-R&D activity ($nrd\_return_{t-5,t-1}$, and $nrd\_return_{t-1,t}$).

Primary inferences are consistent with the tenor of our prior tables. That is, even though R&D is positively associated with future profitability (as shown in prior studies), it does not bias future earnings forecasts in that the coefficients on both $rdme_{t-5}$, $rd\_return_{t-1,t}$ and $rd\_return_{t-5,t-1}$ are all insignificant. Rather, the biased earnings forecasts are actually due to the non-R&D activity of R&D firms captured by $nrd\_return_{t-\tau,t}$, in particular $nrd\_return_{t-5,t-1}$.[12]

[12] The insignificant relation between $nrd\_return_{t-1,t}$ and analyst forecast errors is likely because $nrd\_return_{t-1,t}$ jointly captures elements related to the opposing forces of short term return momentum and long term return reversal, which each have opposing relations with analyst forecast errors.

5.2 Differential investor interpretation of earnings information

An alternative interpretation of the results we report in Tables 2 and 3 is that our non-accounting based return metric, $nrd\_return_{t-\tau,t}$, explains a significantly larger percentage of cross-sectional future return variation in firms with noisy earnings. In other words, if R&D decreases the interpretability of earnings, investors will weight it less than they should and $nrd\_return_{t-\tau,t}$ will absorb the excess variation. To address this concern, we examine whether there is a difference in how R&D affects investors' interpretation of earnings. If R&D affects the manner in which investors weight the information contained in earnings, then we should find differential slope coefficients across firm types with varying R&D levels.

We decompose log book-to-market (bm_t) using the same research design as noted in Sect. 3 for $rdme_t$. We interpret log book return ($book\_return_{t-1,t}$) as a measure of earnings and $intangible\_return_{t-\tau,t}$ as a measure of all value-relevant information between $t-\tau$ and t not captured by log book return (or lagged book-to-market).[13] This interpretation is consistent with that used in Daniel and Titman (2006). Further, by examining whether significant differences exist between how investors interpret the earnings of firms with varying levels of R&D intensity relative to the earnings of non-R&D firms, inferences can be tied more directly to those in the value/growth literature stream.

We are specifically interested in the relation between future returns and the interaction of R&D and $book\_return_{t-1,t}$. In Table 5, we regress future returns on the log return components of log book-to-market (bm_t) and an R&D rank variable. Specifically, each year we rank all firms into one of five categories. All firms with no R&D investment have an RD_RNK of 0. Firms with non-zero R&D investments are sorted into equal-sized quartiles based on their current R&D intensity level ($rdme_t$), with the maximum RD_RNK = 4. In this specification, the slope coefficient on $book\_return_{t-1,t}$ represents the relation between future monthly returns and log book return for non-R&D firms (when RD_RNK = 0). Accordingly, the slope coefficient on RD_RNK × $book\_return_{t-1,t}$ represents the incremental difference to the coefficient on $book\_return_{t-1,t}$ for R&D firms across varying R&D intensity levels. If this interaction term is significant, this implies that investors' interpretation of earnings is significantly affected by a firm's R&D investment, perhaps due to the noise embedded into earnings by R&D. If the interaction between RD_RNK and $book\_return_{t-1,t}$ is insignificant, this implies that the earnings of R&D firms are no more or less informative than those of non-R&D firms. Similarly, a significant relation between future returns and the interaction of RD_RNK × $intangible\_return_{t-5,t}$ would suggest that investors price non-earnings related information differently for R&D firms than non-R&D

[13] Variation in $\Delta\log(B)_{t-1,t}$ is explained by earnings in period t once equity issuance and repurchase activity is controlled. Since $book\_return_{t-1,t}$ equals $\Delta\log(B)_{t-1,t}$ adjusted for equity issuance, we interpret $book\_return_{t-1,t}$ as representing earnings. We acknowledge that 'dirty surplus' accounting could cause $book\_return_{t-1,t} \neq earnings_t$ in some observations but believe that this assumption is reasonable in expectation (in other words, in expectation, change in book value should equal earnings plus equity issuance/repurchase activity).

Table 5 Regressions of future monthly returns on log-linear return components

Reg.	Int.	bm_{t-1}	RD_ RNK	*book_ return*$_{t-1,t}$	RD_RNK × *book_return*$_{t-1,t}$	*intangible_ return*$_{t-1,t}$	*intangible_ return*$_{t-5,t}$	RD_RNK × *intangible_ return*$_{t-5,t}$	Adj. R^2 (%)
Panel A: Future monthly returns (all firms)									
1	1.557	0.314		−0.310		−0.580			1.48
	(5.64)	(3.72)		(−1.62)		(−4.31)			
2	1.400	0.369	0.313	−0.075	−0.107				1.61
	(5.29)	(4.91)	(4.24)	(−0.38)	(−1.31)				
3	1.225	0.095	0.217	−0.107			−0.295	0.021	2.08
	(4.83)	(0.96)	(2.61)	(−0.51)			(−2.28)	(0.45)	
4	1.218	0.097	0.221	−0.012	−0.098		−0.299	0.022	2.18
	(4.81)	(0.98)	(2.68)	(−0.06)	(−0.93)		(−2.31)	(0.48)	
5	1.252		0.212	−0.070	−0.117		−0.380	0.022	1.84
	(4.79)		(2.40)	(−0.35)	(−1.12)		(−3.97)	(0.47)	
Panel B: Future monthly returns (Price ≥ $5)									
1	1.347	0.307		0.250		−0.241			1.72
	(5.41)	(3.73)		(1.58)		(−1.86)			
2	1.256	0.337	0.178	0.329	0.002				2.37
	(5.33)	(4.56)	(2.42)	(1.82)	(0.02)				
3	1.167	0.199	0.147	0.208			−0.070	0.043	2.40
	(4.79)	(2.40)	(1.87)	(1.69)			(−0.62)	(0.80)	
4	1.179	0.202	0.137	0.177	0.120		−0.058	0.035	2.48
	(4.83)	(2.45)	(1.73)	(0.95)	(1.18)		(−0.51)	(0.65)	
5	1.200		0.115	0.027	0.103		−0.222	0.042	2.12
	(4.89)		(1.39)	(0.15)	(0.99)		(−2.36)	(0.80)	

Table 5 reports the results of Fama and Macbeth regressions of future returns on log-linear return components of log book-to-market (bm_t). bm_{t-1} is the lagged log book-to-market ratio. *book_return*$_{t-1,t}$ is the per share log change in book value. *intangible_return*$_{t-\tau,t}$ is the intangible return between $t-\tau$ and t, computed as the residual from annual regressions of log market return (*market_return*$_{t-\tau,t}$) regressed on $bm_{t-\tau,t}$ and *book_return*$_{t-\tau,t}$. RD_RNK is defined as follows. All firms with no R&D investment have an RD_RNK of 0. Firms with non-zero R&D investments are annually sorted into equal-sized quartiles based on their current R&D intensity level ($rdme_t$) (ranks, 1–4). All coefficients are multiplied by 100. t statistics are reported in parentheses

firms. Similar to prior tables, we present separate results for all firms (panel A) and for firms with shares greater than or equal to $5/share as of June 30, $t+1$ (panel B).

Regression 1 of Table 5 establishes that the relation between bm_t and future returns is due to *intangible_return*$_{t-1,t}$ and bm_{t-1}, not *book_return*$_{t-1,t}$, consistent with the results of Daniel and Titman (2006). Regression 2 directly examines whether log book returns (*book_return*$_{t-1,t}$) are incorporated into price differently for R&D firms than non-R&D firms. Regression 2 adds the R&D rank variable (RD_RNK) and interacts this variable with the book return variable. The significant coefficient on RD_RNK in regression 2 of panel A suggests that future returns are positively related to R&D activity if log book return is zero, consistent with the notion that R&D firms realize higher future returns. However, this relation is only marginally significant in some specifications in panel B, suggestive that the significant relation on RD_RNK noted in panel A may be attributable to characteristics of low-priced stocks. More importantly, across both panels we find no evidence to support the contention that the log book returns of R&D firms, our logarithmic proxy for earnings, are differentially associated with future returns relative to non-R&D firms. This result is consistent with Daniel and Titman (2006) and Resutek (2010) and suggests that investors' properly incorporate the information contained in log book return into price. Regressions 3 and 4 examine whether investors interpret information captured by $intangible\_return_{t-5,t}$ differently for R&D and non-R&D firms. Consistent with inferences from prior regressions, there is no reliable difference between how investors interpret $intangible\_return_{t-5,t}$ between R&D and non-R&D firms. That is, the interactions between RD_RNK $\times$ $intangible\_return_{t-5,t}$ and RD_RNK $\times$ $book\_return_{t-1,t}$ are largely insignificant.

The analysis presented in Table 5 coupled with that reported in prior tables paints a consistent picture. That is, future returns are not reliably associated with the level or change in a firm's R&D investment. Rather, the higher future returns realized by R&D firms are due primarily to other non-R&D related characteristics captured by $nrd\_return_{t-\tau,t}$.

6 Analysis of the composition intangible returns ($intangible\_return_{t-\tau,t}$)

As defined in Sect. 3 and employed throughout this study, $nrd\_return_{t-\tau,t}$ is defined and interpreted by what it is not. That is, $nrd\_return_{t-\tau,t}$ is an aggregation of all value-relevant information investors incorporate into price between $t-\tau$ and t that is unrelated to R&D. Likewise, as described and implemented in Daniel and Titman (2006) and Resutek (2010), returns unrelated to accounting information (termed intangible returns in those studies; $intangible\_return_{t-5,t}$) are interpreted as an aggregation of all value-relevant information investors incorporate into price between $t-\tau$ and t that are unrelated to summary accounting measures. However, neither Daniel and Titman (2006) nor Resutek (2010) examine the composition of the intangible returns. Rather, they merely hypothesize that these variables could be capturing changes in firm risk, changes in earnings expectations, or elements of mispricing. Thus, a still unresolved (and largely unexamined) question is to determine what the non-accounting returns ($intangible\_return_{t-\tau,t}$, $nrd\_return_{t-\tau,t}$) represent.

Determining the composition of non-accounting returns (intangible returns) is not trivial. If the source of intangible returns were easily identified, there would be no value/growth anomaly as researchers would understand what drives the initial returns that later reverse. However, it is generally accepted that stock prices move due to shifts in expectations and that intangible returns are largely capturing shifts in expectations (see Daniel and Titman 2006).[14] Ideally, we would like to construct empirical constructs available at time t that represent the intangible returns realized between $t - \tau$ and t. Empirical difficulties arise due to the

[14] Whether these shifts in expectations as captured by intangible returns are rational or irrational is irrelevant for our purposes. As Fama and French (2008) note, distinguishing between rational and irrational expectations using price-scaled accounting ratios is impossible due to the joint-hypothesis problem of Fama (1970). That is, without a valid model to control for expected returns, it is not possible to determine whether intangible returns are the result of rational or irrational shifts in expectations.

inability to quantify changes in expectations precisely.[15] Thus, we resort to using future realizations as a proxy for both expectations and changes in expectations. Admittedly this is a noisy measure, but because we are only interested in understanding what future firm characteristics are captured in intangible returns (and not interested in predicting future returns), concerns with respect to look-ahead biases are minimal.

To simplify the analysis, we first examine the correlation between the two types of the non-accounting returns ($intangible\_return_{t-5,t}$, $nrd\_return_{t-5,t}$) among R&D firms. The measures are extremely similar with a correlation coefficient of 0.90 (untabulated). Thus, we examine the composition of the broader variable, $intangible\_return_{t-\tau,t}$, also referred to as intangible returns. This avoids discarding non-R&D firms (for which $nrd\_return_{t-\tau,t}$ is undefined), allowing analysis across both R&D and non-R&D firms. This also provides insight into the broader value/growth anomaly. This is important as our results suggest that the R&D return anomaly is a subset of the broader value/growth anomaly given the return patterns and strong correlation between the two return variables.

While the number of elements that could possibly map into intangible returns is limitless, prior studies suggest that certain firm characteristics are more strongly associated with future returns than others. Fama and French (2006) discuss how expected returns are a function of three variables: book-to-market, expected earnings, and expected growth. Accordingly, they suggest that, holding two of the three characteristics constant, changes in the remaining characteristic leads to predictable patterns in future returns. Penman and Reggiani (2010) take a slightly different tack and note that the future return patterns associated with the book-to-market ratio are a function of earnings growth and how far in the future the earnings growth is expected to be realized. These studies, coupled with many other prior empirical studies, suggest that changes in investor expectations of future asset growth, future earnings growth, and future earnings will lead to significant changes in asset price.

Accordingly, because intangible returns by construction represent the change in a firm's book-to-market ratio not explained by summary accounting measures (in other words, earnings), it seems reasonable to assume that intangible returns are capturing changes in investor expectations relating to asset growth, earnings growth, and future earnings. Further, if these relations are significantly different between R&D and non-R&D firms, we can provide insight as to why the value/growth anomaly is stronger in R&D firms (for example, Lev and Sougiannis 1999).[16]

We focus our analysis on the relation between current intangible returns ($intangible\_return_{t-1,t}$, $intangible\_return_{t-5,t}$) with the level of future earnings, future earnings growth, and future asset growth. Consistent with prior R&D studies,

[15] Fama and French (2006) attempt to empirically estimate future earnings and asset growth expectations using broad cross-sectional regressions. Their results suggest that future earnings and asset growth are difficult to estimate (in other words, low R-squared values, particularly with respect to estimating future asset growth).

[16] We limit our analysis of the composition of intangible returns to these three variables since it is likely that changes in investor expectations of these three variables will have the most significant effect on asset price.

we adjust earnings and profitability measures for the R&D investment made in that period to allow for better comparisons to be made across R&D and non-R&D firms.

Panel A of Table 6 reports time-series means of summary future characteristics of R&D and non-R&D firms. We annually sort all firms into quintiles based on current period intangible return ($intangible\_return_{t-1,t}$).[17] We then separately report the summary characteristics of R&D and non-R&D firms across $intangible\_return_{t-1,t}$ portfolios, allowing us to examine whether significant differences exist across R&D and non-R&D firms.

First, current earnings ($book\_return\_rd_{t-1,t}$) and future earnings ($book\_return\_rd_{t,t+1}$) are significantly lower for R&D firms compared with non-R&D firms. Prior studies (for example, Eberhart et al. 2004; Lev et al. 2005) suggest that investors do not appreciate that current R&D leads to higher future earnings, which thereby leads to positive future returns when future earnings are realized. Our per share earnings measure ($book\_return\_rd_{t-1,t}$) shows that even after adjusting for R&D, the future earnings of R&D firms tend to be significantly lower for R&D firms relative to non-R&D firms. Second, panel A shows that the profitability of high R&D intensity firms ($\mathrm{ROA\_RD}_{t-\tau,t}$), captured in quintile 1, tends to increase between the current and future period. Given that per share earnings ($book\_return\_rd_{t-1,t}$ and $book\_return\_rd_{t,t+1}$) for R&D firms is negative over this period, this implies that high R&D intensity firms must be shrinking their asset base by an even larger percentage. In fact, panel A shows that per share asset growth for high R&D intensity firms ($asset\_return_{t,t+1}$) averages −4.6%, almost four times as large as asset growth per share in non-R&D firms. This fact is significant because prior studies that have focused on the changes in profitability between current and future periods for R&D firms have largely ignored the fact that changes in profitability are jointly affected by earnings growth and asset growth. Since asset growth is negatively associated with future returns, the higher future returns realized by firms with higher R&D intensity measures could be a function of the fact that these firms are expected to shrink their asset base in the future year.

Panel B examines the composition of 1-year intangible returns ($intangible\_return_{t-1,t}$) more formally. Specifically, we regress $intangible\_return_{t-1,t}$ against future asset growth ($asset\_return_{t,t+1}$), future earnings ($book\_return\_rd_{t,t+1}$), and future earnings growth ($\Delta book\_return\_rd = book\_return\_rd_{t,t+1} - book\_return\_rd_{t-1,t}$). The purpose of these regressions is twofold. First, we examine whether current period intangible returns are associated with future earnings and growth characteristics consistent with theory. Specifically, current period intangible returns should be positively associated with future earnings and future asset growth, consistent with stylized empirical attributes of growth (value) firms.[18] Likewise, consistent with the intuition of Penman and Reggiani (2010), intangible returns should be negatively associated with future earnings growth. Second, we examine whether these relations are different across R&D and non-R&D firms. If the

[17] Consistent with the empirical design employed in this study (and Daniel and Titman 2006 and Resutek 2010), $intangible\_return_{t-1,t}$ is computed as the residual from annual regressions of $market\_return_{t-1,t}$ regressed on bm_{t-1} and $book\_return_{t-1,t}$.

[18] See Fama and French (2006) for a more extensive discussion on the relation between future asset growth, future earnings, current book-to-market, and future returns.

Table 6 Characteristics of R&D and non-R&D firms and intangible returns

Panel A: Sorts on $ret_{t-1,t}^{i/b}$	R&D firms					Non-R&D firms				
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
$RDME_t$	0.111	0.068	0.054	0.046	0.043	–	–	–	–	–
BM_t	1.300	0.992	0.823	0.655	0.430	1.634	1.214	0.995	0.811	0.551
$intangible\_return_{t-1,t}$	(0.608)	(0.192)	0.003	0.194	0.611	(0.596)	(0.187)	0.004	0.189	0.569
$book\_return\_rd_{t-1,t}$	(0.021)	0.051	0.076	0.089	0.071	(0.014)	0.065	0.089	0.107	0.065
$asset\_return_{t,t+1}$	(0.046)	0.045	0.071	0.096	0.142	(0.012)	0.070	0.097	0.113	0.146
$book\_return\_rd_{t,t+1}$	(0.096)	0.013	0.051	0.080	0.150	(0.079)	0.034	0.081	0.103	0.159
$ROA\_RD_{t-1,t}$	0.036	0.097	0.119	0.136	0.133	0.016	0.058	0.071	0.086	0.092
$ROA\_RD_{t,t+1}$	0.045	0.095	0.117	0.136	0.141	0.020	0.055	0.069	0.085	0.100
Δbook_return_rd	(0.111)	(0.060)	(0.040)	(0.028)	0.040	(0.111)	(0.052)	(0.022)	(0.019)	0.039

Reg	Int.	$asset\_return_{t,t+1}$	RD	RD × $asset\_return_{t,t+1}$	$book\_return\_rd_{t,t+1}$	RD × $book\_return\_rd_{t,t+1}$	*Δbook_return_rd*	RD × *Δbook_return_rd*	Adj. R^2 (%)
Panel B: Dependent variable: $intangible\_return_{t-1,t}$ *(all firms)*									
1	−5.011	46.169	5.295	8.595					8.41
	(−6.90)	(22.50)	(4.00)	(6.63)					
2	−3.988		5.053		42.116	8.224			10.24
	(−4.85)		(3.86)		(24.84)	(5.42)			
3	−5.408	25.292	5.504	2.426	31.773	3.120			11.60
	(−6.56)	(15.67)	(4.18)	(1.62)	(20.62)	(1.79)			
4	−5.282	25.749	5.296	1.645	30.239	6.066	−1.896	−3.061	11.74
	(−6.51)	(15.53)	(4.01)	(1.02)	(17.73)	(2.45)	(−2.09)	(−2.00)	
Panel C: Dependent variable: $intangible\_return_{t-5,t}$ *(all firms)*									
1	−11.921	83.896	15.596	−2.037					10.07
	(−14.28)	(24.46)	(9.19)	(−0.62)					
2	−10.129		14.757		71.053	3.898			11.66
	(−10.48)		(8.96)		(20.68)	(1.10)			
3	−12.606	50.791	15.901	−8.647	50.856	1.547			13.51
	(−12.20)	(18.56)	(9.40)	(−2.44)	(15.69)	(0.37)			
4	−13.703	45.944	15.761	−10.084	67.813	6.505	−19.041	−4.434	14.50
	(−12.06)	(18.34)	(9.65)	(−2.90)	(16.96)	(1.33)	(−7.98)	(−1.53)	

This table reports analysis on the composition of 1-year realized intangible returns ($intangible\_return_{t-1,t}$). Panel A provides summary statistics for R&D firms and non-R&D firms. ROA_RD is return on assets adjusted for R&D expenditures ((OIADP + XRD)/avg. total assets (AT)). $book\ \_return\_rd_{t,t+\tau}$ is equal to log change in book value, adjusted for current year R&D expenditures, $\log((B_t + RD_t/Shares_t)/(B_{t-1}/Shares_{t-1})) + shradj\_fac$. *asset_return* reflects log change in per share total asset growth $\log((AT_t/Shares_t)/(AT_{t-1}/Shares_{t-1})) + shradj\_fac$. RD is an indicator variable equal to one for R&D firms, zero otherwise. Quintiles are sorted based on $intangible\_return_{t-1,t}$. Panels B and C report the results of Fama–Macbeth regressions of current intangible returns ($intangible\_return_{t-1,t}$) on future realizations of per share asset growth ($asset\_return_{t,t+1}$), earnings ($book\_return\_rd\ _{t,t+1}$), and earnings growth (*Δbook_return_rd*). All coefficients are multiplied by 100. *t* statistics are reported in parentheses intangible returns of R&D firms are more strongly associated with future asset growth, future earnings, or future earnings growth, we can provide some insight into why the value/growth anomaly is stronger in R&D firms than non-R&D firms.

Consistent with prior tables and economic intuition, panel B reports that intangible returns are positively associated with future asset growth ($asset\_return_{t,t+1}$) and future earnings ($book\_return\_rd_{t,t+1}$), and these effects are stronger in R&D firms. These results imply that firms expected to realize positive asset growth and/or higher earnings tend to realize higher current intangible returns. Finally, regression 4 of panel B shows that future earnings growth is negatively associated with current period intangible returns, and this relation is larger in R&D firms. Panel C reports relatively weaker interactions between RD and $asset\_return_{t,t+1}$, $book\_return\_rd_{t,t+1}$, and $\Delta book\_return\_rd_{t,t+1}$, but a stronger main effect between future returns and RD.

At first, these relations may appear counter to the general intuition of a positive association between intangible returns and future earnings. However, it actually agrees with prior studies and recent work on the riskiness of earnings growth. First, Fama and French (1995) show that the changes in profitability of value (growth) firms are positive (negative) in future periods. Since positive (negative) intangible returns are associated with growth (value) firms, the negative relation we note in panel B is consistent with the stylized empirical facts established in prior studies. Further, Penman and Reggiani (2010) show that high book-to-market firms tend to have very low (or negative) short horizon earnings expectations but very high long horizon earnings expectations. Hence, to the extent one believes earnings growth is risky, the negative relation between intangible returns and future earnings growth could imply that investors discount high earnings growth more heavily (in other words, high future earnings growth is riskier, leading to an increase in the discount rate, leading to negative intangible returns).

In summary, Table 6 provides suggestive evidence of investors having rational expectations with respect to their pricing R&D firms. Specifically, current period intangible returns are positively associated with future asset growth and future earnings and negatively associated with future earnings growth. These results suggest that the stronger value/growth future return pattern that is associated with R&D firms is at least partially a function of the fact that investors expect high R&D firms to contract their asset base and grow their earnings at a higher rate that non-R&D firms.

Ultimately, the analysis presented in Table 6 is only descriptive. The nebulous nature of intangible returns coupled with the imprecise empirical designs we have to forecast future earnings and asset growth prevent us from explicitly linking current period intangible returns to current period changes in growth expectations. Further, even if we could precisely estimate changes in investor expectations of future asset and earnings growth, we could not definitively argue that these changes are based on rational or irrational expectations since intangible returns are derived from book-to-market (Fama and French 2008). Nonetheless, the evidence reported in Table 6 suggests that R&D firms realize slightly different growth in future periods relative to other non-R&D firms realizing similar current period intangible returns.

7 Additional robustness tests

7.1 Comments on alternative R&D intensity scaling variables

Prior studies have used alternative scaling variables (for example, total assets, sales, net operating assets) to construct R&D-related variables. While each scaling variable has marginal positive and negative attributes compared with the other scaling variables, they are all strongly related to firm growth, which is strongly associated with future returns. For example, just as there is a strong negative association between changes in market value (whether due to intangible returns or equity issuance) and future returns, there is also a strong negative association between asset growth (Cooper et al. 2008), sales growth (Lakonishok et al. 1994), and net operating asset growth (Fairfield et al. 2003) and future returns. In unreported robustness tests, we find that any positive relation between R&D intensity as defined using other non-price scaling variables and future returns becomes insignificant once our non-R&D return measure was controlled. We do not report these results because the strongest relation with future returns, by far, is when market value of equity is utilized as the scaling variable (for example, Chan et al. 2001).

7.2 Untabulated robustness tests

We examine the robustness of our tests to a variety of additional tests. We exclude firms with smaller market capitalizations (less than $10 million) and firms with market capitalizations below the NYSE 20th percentile. The general tenor of these results agree with those shown in the main paper: future return variation that prior studies attribute to R&D intensity and/or R&D growth is primarily due to a variable that is unrelated to R&D ($nrd_return_{t-5,t}$ or $nrd\_return_{t-1,t}$). That is, the higher future returns realized by R&D firms do not appear to be related to investors mispricing R&D but rather associated with the other non-R&D growth-related attributes of R&D firms.

8 Conclusion

This study examines the relation between R&D, earnings forecasts, and future returns. Prior studies find positive relations between R&D and both future earnings and future returns. Several studies combine these findings to argue that R&D is mispriced due to naïve investors being “surprised” by predictable earnings patterns related to the R&D investment cycle of a firm. Our results suggest that R&D is not mispriced by investors and that investors and analysts incorporate R&D information into their forecasts of future earnings without bias. We find that the return patterns of R&D firms are essentially a transformation of the value/growth anomaly rather than a distinct anomaly.

Our results contribute to several research fronts in both accounting and finance. First, we find that the higher future returns realized by R&D firms are not associated with the firm's R&D investment decisions. This suggests that R&D is neither mispriced nor does it directly increase a firm's systematic risk. Thus, our evidence implies that the conservative manner in which GAAP requires immediate R&D expensing does not lead to an inefficient allocation of resources.

Second, we provide initial empirical evidence that maps the composition of intangible returns into explicit variables. While Daniel and Titman (2006), Fama and French (2008), and Resutek (2010) note possible compositions of intangible returns, they do not attempt to directly map intangible returns into explicit realizations. Our empirical evidence suggests that intangible returns are associated with future asset growth, future earnings, and future earnings growth.

Finally, our results speak to the need to carefully consider the underlying economic dynamics of a firm. There is ample empirical evidence to suggest that popular empirical asset pricing models are not well-specified, especially with respect to certain subsets of firms. While a common explanation offered in the literature when significant abnormal returns are produced is to claim that these assets are mispriced, careful consideration should be given to the fact that the abnormal returns could be due to a transformation of another accounting anomaly or unique economic dynamics that affect certain subsets of firms.

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