# R&D Reporting Biases and Their Consequences*

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## Abstract

The immediate expensing of research and development (R&D) expenditures is often justified by the conservatism principle. However, no accounting procedure consistently applied can be conservative throughout the firm's life. We therefore ask the following questions: (1) When is the expensing of R&D conservative and when is it aggressive, relative to R&D capitalization? (2) What are the capital-market implications of these reporting biases? To address these questions we construct a model of profitability biases (differences between reported profitability under R&D expensing and capitalization) and show that the key drivers of the reporting biases are the differences between R&D growth and earnings growth (momentum), and between R&D growth and return on equity (ROE). Companies with a high R&D growth rate relative to their profitability (typically early life-cycle companies) report conservatively, while firms with a low R&D growth rate (mature companies) tend to report aggressively under current generally accepted accounting principles. Our empirical analysis, covering the period 1972–2003, generally supports the analytical predictions.

In the valuation analysis we find evidence consistent with investor fixation on the reported profitability measures: we detect undervaluation of conservatively reporting firms and overvaluation of aggressively reporting firms. These misvaluations appear to be corrected when the reporting biases reverse from conservative to aggressive and vice versa. This evidence is consistent with behavioral finance arguments about investor cognitive biases.

**Keywords** Financial reporting biases; Market valuation; Mispricing; R&D

**JEL Descriptors** M4, O3, G14

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# Les distorsions de l'information relative à la R&D et leurs répercussions

## Condensé

Le principe de prudence justifie souvent la passation en charges immédiate des dépenses de recherche et de développement (R&D). Toutefois, aucune méthode comptable appliquée de façon uniforme ne saurait respecter le principe de prudence pendant la durée de vie entière d'une entreprise. Les auteurs posent donc les questions suivantes : a) Quand la passation en charges de la R&D, par opposition à l'inscription à l'actif, est-elle *prudente* et quand est-elle *audacieuse* ? et b) Quelles sont les répercussions sur le marché financier des distorsions de l'information relative à la R&D ? Pour répondre à ces questions, les auteurs élaborent un modèle des distorsions de l'information relative à la rentabilité (c'est-à-dire des différences que présente cette information selon que la R&D est passée en charges ou inscrite à l'actif) et utilisent leurs répercussions pour étudier les conséquences de la passation en charges de la totalité de la R&D.

La passation en charges de la totalité de la R&D entraîne une sous-estimation du bénéfice ainsi que de l'actif total, à chaque période. Elle influe donc à la fois sur le numérateur et le dénominateur de deux variables financières déterminantes abondamment utilisées par les investisseurs : le rendement des capitaux propres (RCP) et le taux de croissance des bénéfices. De leur modèle, les auteurs dérivent et testent les hypothèses suivantes :

HYPOTHÈSE 1. *La variable g dénotant le taux de croissance de la R&D, si* [g/(1 + g/2)] *est supérieur (inférieur) au RCP publié, l'inscription à l'actif de la R&D produira un RCP supérieur (inférieur) à celui que produirait la passation en charges de la R&D.*

HYPOTHÈSE 2. *Si le taux de croissance de la R&D est supérieur (inférieur) au taux de croissance des bénéfices lorsque la R&D est passée en charges, le taux de croissance des bénéfices lorsque la R&D est inscrite à l'actif sera supérieur (inférieur) au taux de croissance des bénéfices lorsque la R&D est passée en charges.*

L'analyse empirique à laquelle procèdent les auteurs pour tester ces hypothèses s'appuie sur un vaste échantillon de sociétés des États-Unis, couvrant une période de 32 ans (1972 à 2003), et fait appel à une méthodologie de portefeuille. Suivant cette méthodologie, les sociétés de l'échantillon sont d'abord classées chaque année dans trois portefeuilles, par ordre de décroissance de l'expression [taux de croissance de la R&D – taux de croissance des bénéfices (ou RCP)]. À l'intérieur de chacun de ces trois portefeuilles, les sociétés sont ensuite classées dans trois portefeuilles par ordre de décroissance de la R&D par rapport au chiffre d'affaires (intensité de la R&D), ce qui donne au total neuf portefeuilles. Une analyse empirique de ces portefeuilles valide les deux hypothèses étudiées et permet aux auteurs de conclure que les distorsions de l'information relative à la rentabilité sont réelles et semblent significatives, tant dans le cas du RCP que dans celui du taux de croissance des bénéfices. En général, les sociétés présentant des taux de croissance de la R&D qui sont élevés par rapport à leur rentabilité (ce qui est souvent le cas dans les secteurs en émergence comme la biotechnologie et chez les jeunes entreprises) font preuve de prudence dans l'information qu'elles publient, tandis que les sociétés dont le taux de croissance de la R&D est faible (ce

qui est le cas des sociétés à maturité) font preuve d'audace. L'analyse révèle également que les distorsions de l'information sont sensiblement plus importantes pour le taux de croissance des bénéfices que pour le rendement des capitaux propres. Par conséquent, le point de vue fort répandu selon lequel la passation en charges des placements incorporels conduit généralement à la prudence dans la publication d'information relative à la rentabilité est un point de vue erroné.

Les auteurs analysent ensuite le rendement des actions des sociétés de l'échantillon afin de déterminer si les investisseurs perçoivent bien le fait qu'au long du cycle de vie de la société, l'application uniforme de la passation en charges de la R&D entraînera tantôt la sous-estimation, tantôt la surestimation de la rentabilité, selon les périodes. La théorie de la finance behavioriste et les faits observés donnent à penser que les investisseurs peuvent commettre des erreurs systématiques lorsqu'ils traitent l'information publiée pour déterminer quelles seront leurs attentes relatives aux flux de trésorerie futurs (par ex., Barberis *et al.*, 1998 ; Lakonishok *et al.*, 1994 ; Poteshman, 2001). À partir de cette théorie, les auteurs élaborent et testent les hypothèses suivantes :

HYPOTHÈSE 3. *Les sociétés dont le taux de croissance de la R&D,* g, *est tel que* $[g/(1 + g/2)]$ *est supérieur (inférieur) au RCP publié ont des rendements anormaux négatifs (positifs) qui se transforment en rendements positifs (négatifs) lorsque le taux de croissance de la R&D chute au-dessous (s'élève au-dessus) du seuil* $2RCP/(2 - RCP)$.

HYPOTHÈSE 4. *Les sociétés dont le taux de croissance de la R&D est supérieur (inférieur) au taux de croissance du bénéfice publié ont des rendements anormaux négatifs (positifs) qui se transforment en rendements positifs (négatifs) lorsque le taux de croissance de la R&D devient inférieur (supérieur) au taux de croissance du bénéfice publié.*

Pour tester ces hypothèses, les auteurs calculent d'abord une série chronologique de rendements anormaux pour chaque société. Les rendements anormaux sont les résidus de la régression des rendements futurs sur divers facteurs connus comme la taille, le ratio valeur comptable/cours, l'effet de levier, les dépenses en immobilisations de R&D et les rendements antérieurs. Les auteurs se demandent ensuite si le profil des séries chronologiques de rendements anormaux correspond au profil de la distorsion de l'information attribuable à la passation en charges de la R&D. Ils analysent trois portefeuilles : a) celui des sociétés qui font preuve soit de prudence soit d'audace de façon uniforme (au fil du temps), sans passer d'une catégorie à une autre (le portefeuille *NR — non-reversal*) ; b) celui des sociétés qui passent d'une distorsion positive à une distorsion négative (le portefeuille *PN*) ; et c) celui des sociétés qui passent d'une distorsion négative à une distorsion positive (le portefeuille *NP*). Ils constatent que les rendements anormaux des sociétés du portefeuille *NR* se distribuent de façon aléatoire autour de zéro, tandis que les rendements des sociétés du portefeuille *PN* augmentent dans les premières années (lorsque la distorsion de l'information est positive) et diminuent dans les années suivantes (lorsque la distorsion de l'information est négative). Le portefeuille *NP* affiche, au contraire, la propriété diamétralement opposée de rendements anormaux initiaux négatifs suivis de rendements anormaux positifs dans l'année où la distorsion des valeurs publiées passe du positif au négatif.

Les résultats de cette analyse empirique confirment les hypothèses 3 et 4. Les auteurs relèvent donc des preuves systématiques de l'existence d'erreurs d'évaluation : les actions des sociétés dont l'information est guidée par la prudence sont systématiquement sous-évaluées, tandis que celles dont l'information est guidée par l'audace sont surévaluées. Fait à noter, ces erreurs d'évaluation tendent à se corriger lorsque les distorsions de l'information passent de la prudence à l'audace, et vice versa. Les répercussions que peut avoir l'application d'une méthode comptable (la passation en charges de la R&D) sur l'évaluation sont distinctes des répercussions précédemment définies, comme celles de la taille de l'entreprise, du ratio valeur comptable/cours et de l'intensité de la R&D. Cette attestation de l'existence d'erreurs d'évaluation concorde avec une heuristique behavioriste appelée *représentativité*, en vertu de laquelle les investisseurs, qui tendent à considérer le profil des données publiées comme étant représentatif du profil des données futures, surréagissent. L'erreur d'évaluation qui en résulte se corrige lorsque le profil des données publiées change et que les investisseurs se rendent compte que leurs certitudes initiales étaient poussées à l'extrême (par ex., Shleifer, 2000).

L'erreur d'évaluation systématique des titres a pour conséquence sociale de nuire à la qualité des décisions d'affectation des ressources, tant sur les marchés de produits que sur les marchés financiers. Ainsi, la sous-évaluation systématique des actions oblige les sociétés sous-évaluées à porter le fardeau d'un coût du capital excessif, ce qui les conduit à des décisions d'investissement sous-optimales et à une croissance médiocre. Sur les marchés financiers, l'erreur d'évaluation des titres entraîne des transferts de richesse entre actionnaires existants et nouveaux actionnaires. D'évidence, l'atténuation des erreurs d'évaluation profite aux sociétés, aux actionnaires et à la société dans son ensemble. Il convient toutefois de noter que rien ne certifie qu'une directive des PCGR exigeant l'inscription à l'actif de la R&D puisse éliminer toutes les erreurs d'évaluation actuelles, bien que les constatations préliminaires (notamment celles d'Aboody et Lev, 1998) soient encourageantes.

Entre autres travaux en comptabilité et en finance ont été réalisées des recherches approfondies liées à la présente étude. Les auteurs expliquent en quoi leur recherche enrichit les études précédentes. Divers chercheurs ont maintes fois démontré l'existence d'une relation positive significative entre l'intensité de la R&D et les rendements subséquents des actions — soit l'effet de l'intensité de la R&D (par ex., Lev et Sougiannis, 1996, 1999 ; Chan *et al.*, 2001 ; Chambers *et al.*, 2002 ; Penman et Zhang, 2002 ; Eberhard *et al.*, 2004). Cet effet de l'intensité de la R&D est notamment expliqué par l'erreur d'évaluation des dépenses de R&D (Chan *et al.*, 2001 ; Eberhard *et al.*, 2004) de même que par la prime de risque (Chambers *et al.*, 2002). Dans la présente étude, les auteurs démontrent qu'outre l'effet de l'intensité de la R&D, il existe un effet significatif de distorsion de l'information relative à la rentabilité. Les sociétés dont l'information relative à la rentabilité et au taux de croissance des bénéfices est guidée par la prudence (soit celles qui font preuve de prudence comparativement aux mêmes indicateurs lorsque la R&D est inscrite à l'actif) sont sous-évaluées, tandis que les sociétés dont l'information relative à la rentabilité et au taux de croissance des bénéfices est guidée par l'audace sont surévaluées. Ces erreurs d'évaluation sont distinctes des effets de l'intensité de la R&D sur les rendements subséquents démontrés dans les études précédentes. Fait intéressant, les erreurs d'évaluation liées à l'information relevées par les auteurs se corrigent lorsque les distorsions de l'information passent de la prudence à l'audace et vice versa. La contribution des auteurs réside donc dans la détermination d'une source d'erreurs d'évaluation du marché financier, singulière et intéressant particulièrement la comptabilité : les distorsions de l'information attribuables à la passation en charges de la R&D. De plus, les faits recueillis par les auteurs viennent étayer l'argumentation de la finance behavioriste relative aux distorsions cognitives des investisseurs (par ex., Barberis et Thaler, 2003).

Grâce à leur modèle analytique, les auteurs contribuent à la recherche en structurant de façon cohérente les distorsions de l'information relative à la rentabilité découlant de l'application de règles comptables différentes et en étayant empiriquement l'existence de ces distorsions dans les données de leur échantillon. Le fait que la passation en charges immédiate de dépenses — comme les dépenses de R&D — qui croissent se traduise par une information « prudente », tandis que la passation en charges de dépenses qui s'amenuisent se traduit par une information « audacieuse », est un thème régulièrement abordé dans la recherche comptable et l'analyse des états financiers (par ex., Beaver et Ryan, 2000 ; Monahan, 2004 ; Danielson et Press, 2004). Toutefois, le taux de croissance auquel la prudence comptable bascule et se transforme en audace dans l'information publiée dépend, ainsi que le démontre le modèle des auteurs, de la mesure particulière de la rentabilité que l'on utilise. Les auteurs ajoutent aux études précédentes en décrivant les seuils prudence-audace, en ce qui a trait à l'information, des trois mesures clés de la rentabilité : le RCP, le rendement de l'actif et le taux de croissance des bénéfices. Ils utilisent ensuite ces seuils pour effectuer des analyses empiriques dont les résultats éclairent le débat que suscite le choix entre passation en charges et inscription à l'actif de la R&D.

## 1. Introduction

The immediate expensing of practically all internally generated intangible investments in the United States, a questionable procedure given the substantial future benefits of many such investments, is often justified by the conservatism principle.[1] Conservative accounting procedures, goes the argument, counter managers' prevalent optimism,[2] and are appropriate given the generally high level of uncertainty associated with the outcome of intangible investments.[3] However, no accounting procedure consistently applied can be conservative (or aggressive) forever. Over the lifetime of the enterprise, if reported earnings under a conservative accounting rule are understated (relative to a less conservative rule) during certain periods, they have to be overstated in other periods, given that conservative/aggressive accounting procedures essentially shift earnings from one period to another. What, then, are the conditions under which the expensing of research and development (R&D) (and other intangibles) will be conservative or aggressive, relative to the capitalization of R&D? What are the capital-market consequences — namely, investors' misvaluations of securities — of such conservative (understated earnings) or aggressive (overstated earnings) financial reporting?

We address these two questions in the current study. We focus on three widely used indicators of performance — the return on equity (ROE), return on assets (ROA), and earnings growth (momentum) — and derive the general conditions under which R&D expensing (the current generally accepted accounting principles [GAAP] procedure) will result in overstated or understated values of these indicators, relative to capitalized R&D. We then examine the validity of these general conservative/aggressive conditions on the sample data.[4] Finally, we address the investor rationality question: Is the conservative/aggressive reporting of enterprise profitability induced by the expensing of R&D systematically affecting the pricing of securities? That is, do investors properly perceive that, over the life cycle of the firm, a consistent application of R&D expensing will lead to understatement of profitability in some periods and to overstatement in others?

Our empirical analysis, based on a comprehensive sample spanning 32 years (1972–2003), validates the general conditions derived analytically for R&D expensing to generate conservative or aggressive reporting. With respect to investor rationality, we find systematic evidence of mispricing: stocks of conservatively reporting firms are systematically undervalued, while those of aggressively reporting firms are overvalued. Notably, these mispricings tend to be corrected when the reporting biases switch from conservative to aggressive, and vice versa. These valuation effects of an accounting practice (R&D expensing) are distinct from previously established effects, such as those of firm size, book-to-market ratio, and R&D intensity. This mispricing evidence is consistent with a behavioral heuristic known as representativeness, which makes investors view patterns in reported data as representative about future patterns and thus leads them to overreact. The resulting mispricing is corrected when the pattern in reported data changes and investors realize that their initial beliefs were too extreme (e.g., Shleifer 2000).

The accounting and finance literature includes extensive research related to our study. We note here our contribution relative to previous studies. Various studies have consistently documented a significant positive relationship between R&D intensity and subsequent stock returns (the R&D intensity effect) (e.g., Lev and Sougiannis 1996, 1999; Chan, Lakonishok, and Sougiannis 2001; Chambers, Jennings, and Thompson 2002; Penman and Zhang 2002; Eberhard, Maxwell, and Siddique 2004). Explanations for the R&D intensity effect include both mispricing of R&D expenditures (Chan et al., Eberhard et al.) and risk premium (Chambers et al.) arguments. We demonstrate below that in addition to the R&D intensity effect, there is a significant reporting profitability bias effect. Firms that report conservative profitability and earnings growth (that is, conservative as compared with the same indicators under R&D capitalization) are undervalued, whereas firms that report aggressive profitability and earnings growth are overvalued. These over/under valuations are distinct from the effects of R&D intensity on subsequent returns demonstrated in previous studies. Interestingly, our reporting-related misvaluations are corrected when the reporting biases reverse from conservative to aggressive and vice versa. Our contribution thus lies in identifying a distinct source of capital-market misvaluation that is particularly relevant to accounting — that is, reporting biases due to R&D expensing.[5] In addition, our evidence provides further support to behavioral finance arguments about investor cognitive biases (e.g., Barberis and Thaler 2003).

Our analytical model contributes to the literature by developing a unified structure of reported profitability biases arising from alternative accounting rules and documenting empirically the presence of such biases in the sample data. The fact that the immediate expensing of growing expenditures such as R&D results in conservative reporting, whereas the expensing of shrinking expenditures results in aggressive reporting, is a standard feature of accounting research and financial statement analysis (e.g., Beaver and Ryan 2000; Monahan 2005; Danielson and Press 2004). However, the rate of growth at which conservative accounting tips over into aggressive reporting depends, as our model shows, on the particular profitability measure used. We add to prior studies by outlining the cutoff points for conservative/aggressive reporting for three key profitability measures: ROE, ROA, and earnings growth (momentum). We then use the cutoff points to carry out empirical analyses that generate new insights on the R&D expensing versus capitalizing controversy.[6]

The remainder of the paper proceeds as follows. In section 2 we construct a model that allows us to identify the drivers of profitability reporting biases and derive testable hypotheses for the existence and consequences of the biases. In section 3 we discuss data sources and variable definitions. We validate the model by comparing its predictions to the sample reporting biases in section 4. In section 5 we test the capital-market consequences of the biases, and section 6 contains concluding remarks.

## 2. Conservative and aggressive reporting under R&D expensing

In this section we derive the general conditions under which the expensing of R&D will generate conservative (understated) or aggressive (overstated) performance measures, relative to performance measured under the capitalization and amortization of R&D. In this study we do not prescribe the capitalization or expensing of R&D or other intangibles. Rather, we postulate that if R&D expenditures have, under certain circumstances, future benefits, their immediate expensing will lead to systematic performance reporting biases relative to underlying earnings under R&D capitalization. Our interest here is in deriving general rules for identifying such biases.

The analytical results are derived under an assumption of steady R&D growth, captured through an exogenous parameter, $g$. Assume that a firm has an initial expenditure $C$ of R&D in year 1 and that R&D grows at a rate $g$ per year. Thus, the R&D expenditure in year $t$ would be $C(1 + g)^t$. The issue we address is the comparison of profitability indicators when the firm expenses R&D expenditure in year $t$ as opposed to capitalizing and amortizing it over $T$ years (under the assumption that cash flows are unaffected by the accounting policy and that other reporting choices are unchanged). We assume that under the expensing method, the firm has in year $t$ earnings of $E_t$ and book value of equity (assets) of $BVE_t$ ($BVA_t$). Our analysis relates to years $t > T$ — that is, after a full R&D amortization cycle is complete. Only in this case can meaningful comparisons be made between expensing and capitalizing policies.

It is important to note, at least from a theoretical perspective, that the results derived in this section can also be obtained in two more complex settings. The first is where R&D investment determines earnings growth. The second is where there are multiple assets with depreciation calculated on a continuous basis. We do not report those results mainly because they do not lead to any significant changes in our empirical tests. It is worth noting, however, that each of these settings generates empirical predictions that may be a potential area for future research.[7]

Variables are defined as follows:

| | |
|---|---|
| $E_t$ | = earnings in year $t$ under expensing of R&D, |
| $E_t^c$ | = earnings in year $t$ under capitalization and amortization of R&D, |
| $BVA_t$ ($BVE_t$) | = book value of assets (equity) at end of year $t$ under expensing of R&D, |
| $BVA_t^c$ ($BVE_t^c$) | = book value of assets (equity) at end of year $t$ under capitalization and amortization of R&D, |
| $EM_t$ ($EM_t^c$) | = earnings growth from year $t-1$ to $t$ (momentum) under expensing (capitalization) of R&D. |
| $T$ | = amortization period of R&D investment (for capitalizing firms), |
| $g$ | = annual growth rate of R&D expenditures, |
| $C$ | = R&D expenditure in year 1, and |
| $\tau$ | = tax rate. |

In the following analysis, we focus on three widely used measures of operating performance: ROE, ROA, and the earnings growth (momentum).

PROPOSITION 1. ROA, ROE, AND NONZERO R&D GROWTH RATE. *The R&D expensing firm reports a higher ROA than the capitalizing firm if and only if* $ROA \geq (1-\tau)g/(1+g/2)$. *The analogous result for ROE is* $ROE \geq g/(1+g/2)$.

For proof, see the appendix.

PROPOSITION 2. EARNINGS MOMENTUM AND NONZERO R&D GROWTH RATE. *The R&D expensing firm reports a higher earnings growth rate (EM) than the capitalizing firm if and only if* $EM_t \geq g$. *That is, an expensing policy results in a higher reported earnings momentum if and only if the growth of R&D expenditures is slow relative to the reported (under expensing) earnings growth.*

For proof, see the appendix.

A qualification to the preceding propositions concerns the underlying assumption that earnings are positive and higher under capitalization than under expensing (see the appendix). For example, Proposition 2 fails if $E_t > E_t^c$ or if $E_t < 0$. Similarly, Proposition 1 depends on a steady growth in R&D over the entire amortization period and may fail if growth is uneven or negative in some years.[8]

Given the expensing rule for R&D expenditures mandated by *Statement of Financial Accounting Standards* (*SFAS*) *No. 2* (FASB 1974), our above propositions lead us directly to the following testable hypotheses.

HYPOTHESIS 1. *Let g denote the R&D growth rate. If* $[g/(1 + g/2)]$ *is greater (less) than reported ROE, then ROE under R&D capitalization is greater (less) than ROE under expensing of R&D.*

HYPOTHESIS 2. *When the R&D growth rate is greater (less) than earnings growth under R&D expensing, then earnings growth under capitalization is greater (less) than earnings growth under R&D expensing.*

Thus, we have established cutoff rules indicating when reported profitability will be conservative (reported *ROE*, *ROA*, and earnings growth lower than under capitalization), and when reported profitability will be aggressive (reported indicators higher than under capitalization).

In addition, our propositions imply that under the current expensing rule, understanding the relationship between R&D investment growth and profitability is important for stock market valuation purposes. In theory, market value should be based on economic profitability, and any distortions of economic profitability measures due to the application of economically inconsistent accounting rules could lead to stock market misvaluations if investors fixate on reported profitability.

Behavioral finance theory and evidence suggests that investors can make systematic errors when they process public information to form expectations about future cash flows (e.g., Barberis, Shleifer, and Vishney 1998; Lakonishok, Shleifer, and Vishney 1994; Poteshman 2001). The theory refers to a behavioral heuristic known as representativeness. Investors who display this heuristic view patterns in reported data as representative about future patterns (extrapolate) and ignore the laws of probability that changes in future patterns can occur.[9] In other words, investors fixate on the reported pattern and, especially if the pattern persists for some periods (there is a trend), they overreact and push prices up or down depending on the nature of the pattern. The resulting mispricing should then be mostly corrected when the pattern in reported data changes and investors realize that their initial beliefs were too extreme.

According to this theory, if investors in our sample R&D firms display the representativeness heuristic, we should find evidence of predictable investor misreaction. Thus, for firms with R&D growth rates sufficiently *large relative to reported profitability*, the theory predicts that investors will push prices down because they fixate on the low reported profitability caused by the relatively large R&D expenditures and think that the current pattern of low profitability is representative of future profitability. The presence of undervaluation in this case will manifest in significantly negative abnormal returns when R&D growth exceeds reported profitability. The theory also predicts that investors will correct their undervaluation when R&D growth rates fall below reported profitability. At that point, the drop in R&D growth and the realization of benefits from past R&D push reported profitability above past profitability and investors find out that their initial expectations were too extreme. The correction of the undervaluation will manifest in significantly positive abnormal returns when the R&D growth rate drops below the cutoff values indicated in our propositions. Correspondingly, for firms with R&D growth rates sufficiently *small relative to reported profitability*, the theory predicts an initial overvaluation (positive abnormal returns) followed by a correction (negative abnormal returns) when the R&D growth rate increases above the cutoff values indicated in our propositions. On the basis of the above reasoning, we develop the following testable hypotheses:

HYPOTHESIS 3. *Firms with an R&D growth rate g, such that* $[g/(1 + g/2)]$ *is greater (less) than reported ROE, have negative (positive) abnormal returns that revert into positive (negative) when the R&D growth rate drops below (becomes greater than) the cutoff* $2ROE/(2 - ROE)$.

HYPOTHESIS 4. *Firms with an R&D growth rate greater (less) than reported earnings momentum have negative (positive) abnormal returns that revert to positive (negative) when the R&D growth rate becomes less (greater) than reported earnings momentum.*

The importance of systematic misvaluations, if present, is that they may lead to social harm. Systematic undervaluations, for example, imply an excessively high cost of capital, which in turn hinders investment and growth. Conversely, overvaluations lead to undesirable wealth transfers from outside investors to insiders, given the considerable information asymmetries associated with R&D.[10] The remainder of the paper empirically tests the above four hypotheses.

## 3. Data and measures

Our sources of data are the COMPUSTAT and Center for Research in Security Prices (CRSP) data bases. We use data from the period 1972 to 2003, and include in our samples all firms with valid data in the COMPUSTAT Active and Research files for the following variables: sales (item no. 12), R&D expenditures (item no. 46), book value of common equity (item no. 60), and net income (item no. 172). Market value of common equity (price per share times number of shares outstanding), and stock returns are derived from the CRSP Stock Return files.

For each firm we compute the annual R&D amortization (distinct from the R&D expenditure, which is expensed in the financial report) as well as the R&D capital calculated from the time series of reported R&D expenses (COMPUSTAT item no. 46). The R&D amortization and capital values are used to derive earnings and book values under R&D capitalization by adjusting both reported earnings (COMPUSTAT item no. 172) and book values of equity (COMPUSTAT item no. 60). Firm-specific estimates of R&D amortization are generally too noisy and unreliable, given the relatively short time series of R&D available and the high serial correlation of annual R&D expenditures for most firms. Industry-specific amortization rates, such as those estimated by Lev and Sougiannis 1996, are more reliable. For this study, encompassing all COMPUSTAT companies with R&D data, we adopt a uniform R&D amortization rate of 20 percent per year.[11] Accordingly, the R&D amortization of firm *i* in year *t* ($RDA_{it}$) is 20 percent of all the previous R&D expenditures (vintages) that are still productive (that is, not fully amortized):

$$RDA_{it} = 0.2*(RD_{it-1} + RD_{it-2} + RD_{it-3} + RD_{it-4} + RD_{it-5}) \quad (1).$$

The R&D capital of firm $i$ at the end of year $t$ ($RDC_{it}$) is the sum of the unamortized R&D expenditures (vintages) that are still productive:

$$RDC_{it} = RD_{it} + 0.8 \times RD_{it-1} + 0.6 \times RD_{it-2} + 0.4 \times RD_{it-3} + 0.2 \times RD_{it-4} \quad (2).$$

Table 1 provides summary statistics of our sample. The data indicate that R&D expenditures have grown sharply over time. As a percentage of sales, R&D expenditures were 1.70 percent, on average, in 1975 and more than doubled by 2000 to 4.54 percent. It is also interesting to note that as a percentage of earnings, R&D expenditures have grown from 36.1 percent in 1975 to 96.9 percent in 2000. Because firms' R&D expenditures have generally increased over time, the annual R&D amortization is smaller than the annual accounting expense, as indicated by the lower R&D intensity ratios based on R&D capitalization than those based on R&D expensing. The data in Table 1 also show that R&D capital represents a relatively large intangible asset, accounting for 25 percent of the book value of equity in 2000, even with our assumed fast amortization rate of R&D (20 percent per year).

Table 2 presents data on the growth rate of R&D, the growth rate (momentum) of earnings, and return on equity — three key variables in our study. The growth rates of R&D and earnings are computed over five years: $[R\&D \text{ (or } earnings)_t - R\&D \text{ (or } earnings)_{t-4}]/R\&D \text{ (or } earnings)_{t-4}$. When $earnings_{t-4}$ is negative, we use the absolute value in the denominator.[12] Table 2 presents data for the most R&D-intensive industries and for selected years. For practically all industries (except pharmaceuticals), the five-year growth rate of R&D plummeted in 1990, relative to 1985 (for example, from 124.8 percent to 31.4 percent in software), perhaps induced by the onset of the recession in the United States in the early 1990s and by the maturing of several industries. In the software and transportation industries, R&D growth picked up in the early 1990s, and by 2000 there were signs of higher growth in all industries except drugs and pharmaceuticals.[13]

The earnings growth patterns (middle three columns in Table 2) portray a different picture from the R&D growth. The earnings growth of pharmaceutical companies decreased over the period, while their R&D growth was largely constant, perhaps due to health maintenance organization (HMO) and Medicare/Medicaid pressure on drug prices and use in the 1990s. In contrast, the earnings growth rate of computers, measuring instruments, and transportation equipment and electrical equipment companies soared in the first half of the 1990s, despite flat or decreasing growth rates of R&D in those industries. In the second half of the 1990s, however, the earnings growth rates of these industries declined substantially. In particular, a growth rate of 8.8 percent for computers reflects the strong competition in the industry. Communications companies exhibited at the median a negative earnings growth in the early 1990s, probably as a result of the extensive deregulation in this industry (for example, the opening up of intrastate phone service to competition), but they seemed to recover in the late 1990s.

TABLE 1
Sample summary statistics

| Year | R&D expenditures (and accounting expense) as percentage of | | | R&D amortization as percentage of | | | R&D capital as percentage of book value | Number of firms |
|---|---|---|---|---|---|---|---|---|
| | Sales | Earnings | Book value | Sales | Earnings | Book value | | |
| 1975 | 1.70 | 36.1 | 4.13 | 0.86 | 18.14 | 2.08 | 10.55 | 1,280 |
| 1980 | 1.78 | 34.4 | 5.08 | 1.15 | 22.13 | 3.27 | 12.55 | 1,282 |
| 1985 | 3.01 | 83.7 | 8.11 | 2.14 | 59.71 | 5.79 | 21.25 | 1,668 |
| 1990 | 3.40 | 79.4 | 9.59 | 2.61 | 60.86 | 7.35 | 25.76 | 1,665 |
| 1995 | 3.75 | 65.3 | 10.88 | 2.90 | 50.42 | 8.41 | 28.73 | 1,796 |
| 2000 | 4.54 | 96.9 | 9.22 | 3.36 | 71.86 | 6.83 | 24.90 | 3,569 |

**Notes:**

For selected fiscal years from 1975 to 1995, the data indicate total R&D expenditure (the GAAP expense) as well as R&D amortization and R&D capital, calculated for all U.S. firms engaged in R&D and listed on NYSE, AMEX, and NASDAQ with valid data on the COMPUSTAT files. The R&D data are expressed as a percentage of sales, earnings, and book value of equity. Percentages are computed by adding numerator and denominator data across all companies (that is, weighted averages).

R&D expenditures (*RD*) is COMPUSTAT item no. 46.

Sales is COMPUSTAT item no. 12.

Earnings is COMPUSTAT item no. 172.

Book value is COMPUSTAT item no. 60.

R&D amortization for firm *i* at time *t* is equal to $0.2*(RD_{it-1} + RD_{it-2} + RD_{it-3} + RD_{it-4} + RD_{it-5})$.

R&D capital for firm *i* at time *t* is equal to $RD_{it} + 0.8 \times RD_{it-1} + 0.6 \times RD_{it-2} + 0.4 \times RD_{it-3} + 0.2 \times RD_{it-4}$.

TABLE 2
Median growth rates of R&D and earnings and median values of ROE for selected industries (growth rates are measured over five years and presented as percentages)

| SIC | | Five-year R&D growth | | | | Five-year earnings growth | | | | Return on equity | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| code | Industry | 1985 | 1990 | 1995 | 2000 | 1985 | 1990 | 1995 | 2000 | 1985 | 1990 | 1995 | 2000 |
| 737 | Computer programming, software, and services | 124.8 | 31.4 | 100.8 | 100.8 | 74.5 | 32.7 | 75.5 | 98.0 | 11.3 | 2.8 | 7.9 | −27.0 |
| 283 | Drugs and pharmaceuticals | 85.8 | 111.3 | 85.4 | 81.0 | 33.4 | 57.4 | 25.6 | 18.0 | 12.1 | 2.4 | 1.6 | −26.0 |
| 357 | Computers and office equipment | 82.7 | 55.7 | 33.3 | 68.0 | 29.8 | 21.3 | 53.3 | 8.8 | 8.8 | 6.4 | 9.5 | −1.9 |
| 38 | Measuring instruments | 71.0 | 36.2 | 31.5 | 56.7 | 16.4 | 45.7 | 54.4 | 40.4 | 9.3 | 8.4 | 8.8 | 3.6 |
| 36 | Electrical equipment excluding computers | 81.6 | 33.7 | 44.4 | 89.0 | −19.9 | 14.4 | 119.4 | 99.5 | 9.0 | 4.7 | 12.5 | 4.1 |
| 48 | Communications | 123.9 | −7.2 | 6.5 | 19.0 | −91.6 | 105.2 | −47.0 | 97.7 | 1.0 | 18.1 | 4.5 | −9.7 |
| 37 | Transportation equipment | 49.9 | 24.0 | 46.6 | 51.9 | 89.8 | 2.2 | 166.8 | 43.4 | 13.3 | 9.5 | 17.1 | 14.4 |

**Notes:**

R&D growth equals $(RD_t - RD_{t-4})/RD_{t-4}$, where *RD* is R&D expenditures (COMPUSTAT item no. 46).

Earnings growth equals $(earnings_t - earnings_{t-4})/|earnings_{t-4}|$, where earnings is COMPUSTAT item no. 172.

Return on equity equals $earnings_t$ */average book value of equity* at $t - 1$ and $t$.

Book value of equity is COMPUSTAT item no. 60.

Median return on equity (ROE) values vary across years and industries, with the most stable pattern being exhibited by transportation. In 2000, four out of seven industries had negative median ROEs, and apparently software and drug companies suffered large losses.

Considering the main variables driving our analysis, 57 percent of the sample firm-years had an R&D growth rate that was higher than the earnings momentum, leading, according to our model, to conservative reporting of earnings growth and potential market undervaluation. In the remaining 43 percent of the sample cases, the R&D growth rate was lower than the earnings momentum, leading to an aggressive earnings growth reporting and potential market overvaluation. In 58 percent of the firm-years, R&D growth was higher than ROE, leading, according to our model, to conservative ROE reporting with potential market undervaluation, and aggressive reporting in the remaining 42 percent of the cases with potential market overvaluation.

## 4. Validating the model's predictions

In this section we examine the empirical support for Hypotheses 1 and 2 derived from Propositions 1 and 2 in section 2 of this paper. Using the notation $RDG(5)$ for the five-year R&D growth rate, $RDG$ for the annual R&D growth rate, $ROE$ for the reported (R&D-expensed) return on equity, $ROE^C$ for the R&D-capitalized $ROE$, $EM(5)$ for the five-year reported earnings growth (momentum), and $EM(5)^C$ for the five-year earnings momentum under R&D capitalization, we restate our two hypotheses as follows:

HYPOTHESIS 1R. *If* $\{RDG/[(RDG/2) + 1]\} > ROE$, *then* $ROE < ROE^C$, *and the converse for* $\{RDG/[(RDG/2) + 1]\} < ROE$. *Namely, if the growth rate of R&D divided by 1 plus half the R&D growth rate is larger than the firm's ROE under expensing, then that ROE will be conservative (lower than ROE under R&D capitalization).*

HYPOTHESIS 2R. *If* $RDG(5) > EM(5)$, *then* $EM(5) < EM(5)^C$, *and the converse for* $RDG(5) < EM(5)$. *Namely, if the five-year growth rate of R&D is larger than the five-year growth rate of reported earnings under R&D expensing, then reported earnings growth is conservative (lower than reported earnings growth under R&D capitalization).*

Because these relationships are not linear, we use a portfolio approach to examine their validity and then also employ a regression approach.[14] We implement two alternative variations of the portfolio approach. In the first, sample companies with valid data were ranked in each year into nine portfolios, in decreasing sizes of $RDG(5)$ and $EM(5)$ (and alternatively in decreasing sizes of $\{RDG/[(RDG/2) + 1]\}$ and $ROE$). Thus, sample firms were first classified in each year into three portfolios on the basis of decreasing size of earnings momentum, $EM(5)$, and then, within each of the three $EM(5)$ portfolios, firms were classified into three decreasing R&D growth, $RDG(5)$, portfolios. The same procedure was applied to the R&D growth and ROE indicators, yielding nine size-ranked $\{RDG/[(RDG/2) + 1]\}$ and

*ROE* portfolios. In each of the nine $RDG(5) - EM(5)$ portfolios, and the nine $\{RDG/[(RDG/2) + 1]\} - ROE$ portfolios, we focus on the reporting biases in earnings growth (momentum) and ROE — namely, the differences between reported (R&D-expensed) and R&D-capitalized earnings momentum, $EM(5) - EM(5)^C$, and between reported and R&D-capitalized ROE, $ROE - ROE^C$.

In the second variation of the portfolio tests we control for R&D intensity, measured by the R&D expenditures to sales ratio.[15] This is a more demanding test than the above because it controls not only for R&D growth but also for R&D intensity (level of the expenditure), which is likely to affect the size of the reporting bias in ROE and earnings momentum. In this test, sample companies with valid data were ranked in each year into nine portfolios, in decreasing sizes of $RDG(5) - EM(5)$ and R&D-to-sales (and alternatively in decreasing sizes of $\{RDG/[(RDG/2) + 1]\} - ROE$ and R&D-to-sales). Thus, sample firms were first classified in each year into three portfolios on the basis of decreasing size of $RDG(5) - EM(5)$, and then, within each of the three $RDG(5) - EM(5)$ portfolios, firms were classified into three decreasing R&D-to-sales (*RDS*) portfolios. The same procedure was applied to the R&D growth and ROE relationship, yielding nine size-ranked $\{RDG/[(RDG/2) + 1]\} - ROE$ and *RDS* portfolios.

Table 3 presents data for the relationship between annualized R&D growth, $\{RDG/[(RDG/2) + 1]\}$, and return on equity, *ROE*, on the basis of the second test (including R&D intensity).[16] We expect (Hypothesis 1R) that when $\{RDG/[(RDG/2) + 1]\}$ is larger than reported *ROE*, the latter will be smaller than *ROE* under R&D capitalization (namely, conservative reporting), and vice versa for $\{RDG/[(RDG/2) + 1]\} < ROE$. This indeed is the case in the high $\{RDG/[(RDG/2) + 1]\} - ROE$ and high *RDS* portfolio (left-most column): the mean R&D growth $\{RDG/[(RDG/2) + 1]\}$ is (0.408), or 40.8 percent, and is substantially larger than the mean reported *ROE* (−1.511), which in turn is smaller (conservative reporting) than the R&D-capitalized *ROE* (−0.248). In the case of low $\{RDG/[(RDG/2) + 1]\} - ROE$ and high *RDS* portfolio (third from the right-most column), the mean R&D growth $\{RDG/[(RDG/2) + 1]\}$ is (−0.023), or −2.3 percent, and is substantially lower than the mean reported *ROE* (2.115), which in turn is larger (aggressive reporting) than the R&D-capitalized *ROE* (0.253). Thus, in each of the nine portfolios, the empirical relationship between the reported and R&D-capitalized *ROE*s is consistent with Proposition 1's prediction and the related Hypothesis 1 (1R). To abstract from extreme observations, we also computed median values (reported in square brackets in Table 3). Examination of the medians indicates that the expected relationships (reporting biases) hold at the medians too.

The mean and median differences between reported and R&D-capitalized *ROE* are presented in the row labeled Reported *ROE* minus R&D-capitalized *ROE* ($ROE - ROE^C$), with Fama-MacBeth 1973 *t*-statistics in parentheses. All the median differences and all but two mean differences are significantly different from zero. These significance tests imply the presence of strong ROE reporting biases, clearly validating Hypothesis 1 (1R).

TABLE 3
ROE biases: Reported versus R&D-capitalized ROE values

| Annualized R&D growth minus one-year ROE | High | | | Medium | | | Low | | |
|---|---|---|---|---|---|---|---|---|---|
| R&D-to-sales ($RDS$) | High | Medium | Low | High | Medium | Low | High | Medium | Low |
| Annualized R&D growth | 0.408 | 0.454 | 0.422 | 0.126 | 0.137 | 0.119 | −0.023 | −0.022 | −0.057 |
| $\{RDG/[(RDG/2)+1]\}$ | [0.287] | [0.379] | [0.345] | [0.124] | [0.136] | [0.119] | [−0.020] | [−0.008] | [−0.045] |
| Annualized R&D growth minus | 1.919 | 1.455 | 1.519 | 0.092 | 0.067 | 0.058 | −2.138 | −1.101 | −0.393 |
| one-year ROE | [0.841] | [0.568] | [0.543] | [0.091] | [0.056] | [0.043] | [−0.211] | [−0.163] | [−0.188] |
| R&D-to-sales ($RDS$) | 9.283 | 0.119 | 0.029 | 1.066 | 0.046 | 0.011 | 1.215 | 0.028 | 0.006 |
| | [0.708] | [0.113] | [0.026] | [0.120] | [0.044] | [0.011] | [0.097] | [0.026] | [0.006] |
| Reported ROE ($ROE$) | −1.511 | −1.001 | −1.097 | 0.034 | 0.070 | 0.061 | 2.115 | 1.079 | 0.335 |
| | [−0.426] | [−0.124] | [−0.117] | [0.050] | [0.087] | [0.084] | [0.194] | [0.159] | [0.148] |
| R&D-capitalized ROE ($ROE^C$) | −0.248 | −0.116 | −0.260 | 0.062 | 0.077 | 0.061 | 0.253 | 0.130 | 0.202 |
| | [−0.125] | [−0.005] | [−0.044] | [0.078] | [0.094] | [0.086] | [0.076] | [0.126] | [0.133] |
| Reported ROE minus | −1.263 | −0.885 | −0.837 | −0.028 | −0.007 | −0.000 | 1.862 | 0.949 | 0.133 |
| R&D-capitalized ROE | (−5.866) | (−3.078) | (−3.640) | (−4.827) | (−3.069) | (−0.208) | (3.487) | (1.861) | (2.779) |
| ($ROE - ROE^C$) | [−0.272] | [−0.112] | [−0.044] | [−0.020] | [−0.006] | [−0.001] | [0.059] | [0.024] | [0.008] |
| | (−8.023) | (−6.595) | (−5.850) | (−4.924) | (−4.053) | (−3.823) | (10.274) | (13.901) | (16.105) |
| Book-to-market | 0.442 | 0.653 | 0.767 | 0.681 | 0.849 | 0.948 | 0.257 | 0.565 | 0.679 |
| | [0.320] | [0.528] | [0.669] | [0.568] | [0.724] | [0.833] | [0.358] | [0.587] | [0.682] |
| Earnings-to-price | −0.293 | −0.269 | −0.279 | −0.004 | 0.025 | 0.026 | −0.248 | −0.072 | −0.081 |
| | [−0.093] | [−0.038] | [−0.019] | [0.033] | [0.061] | [0.068] | [0.044] | [0.081] | [0.087] |
| Market capitalization | 197 | 783 | 773 | 1,634 | 1,664 | 1,643 | 2,014 | 2,193 | 2,827 |
| ($ millions) | [47] | [57] | [49] | [97] | [114] | [157] | [42] | [119] | [156] |

(The table is continued on the next page.)

TABLE 3 (Continued)

**Notes:**

In each year from 1975 to 2003, sample firms are ranked by annualized R&D growth $\{RDG/[(RDG/2) + 1]\}$ minus one-year ROE and assigned into one of three equally sized R&D growth portfolios. Each R&D growth portfolio is then subdivided into three equally sized R&D intensity portfolios by ranking on R&D-to-sales (*RDS*). Values in the table are means of yearly portfolio means and, in square brackets, means of yearly portfolio medians of various variables over the 29-year period 1975–2003. Numbers in parentheses are Fama-MacBeth *t*-statistics calculated using the 29-yearly mean values. The sample includes all NYSE, AMEX, and NASDAQ firms with coverage on the COMPUSTAT and CRSP files and consists of 56,075 firm-year observations.

Annualized R&D growth (*RDG*) equals $[(RD_t - RD_{t-4})/RD_{t-4}]/4$, where *RD* is R&D expenditures (COMPUSTAT item no. 46). Reported ROE equals $earnings_t / average$ *book value of equity* at $t - 1$ and $t$. Earnings is COMPUSTAT item no. 172. Book value of equity is COMPUSTAT item no. 60. R&D-capitalized ROE equals *adjusted* $earnings_t$ */adjusted average book value of equity* at $t - 1$ and $t$. *Adjusted* $earnings_t$ equals *reported* $earnings_t$ plus *R&D* $expenditures_t$ minus *R&D* $amortization_t$. *R&D* $amortization_t$ equals $0.2*(RD_{it-1} + RD_{it-2} + RD_{it-3} + RD_{it-4} + RD_{it-5})$. *Adjusted book value* equals *reported book value* plus *R&D capital*. *R&D capital* equals $RD_{it} + 0.8 \times RD_{it-1} + 0.6 \times RD_{it-2} + 0.4 \times RD_{it-3} + 0.2 \times RD_{it-4}$. Book-to-market, earnings-to-price, and market capitalization are computed as of the fiscal year-end. R&D-to-sales equals COMPUSTAT item no. 46 divided by COMPUSTAT item no. 12.

The remaining data in Table 3 show that high R&D growth firms are characterized by the lowest book-to-market ratios, reflecting investors' strong growth expectations from high R&D growth companies. These firms are also characterized by relatively low earnings-to-price ratios, particularly pronounced at the medians. This reflects the depressed reported earnings of these firms as a result of expensing R&D. High R&D growth firms also tend to have high R&D intensity. The differences between the mean and the median firm sizes in each portfolio are large, indicating the existence of very large firms in each portfolio.[17]

Table 4 presents data for the relationship between R&D growth and earnings momentum (growth) for nine $RDG(5) - EM(5)$ and *RDS* ranked portfolios, including control for R&D intensity. For this analysis, portfolio formation starts in 1979 because we need five years to construct $EM(5)$. As in the R&D growth and *ROE* analysis (Table 3), sample firms were first ranked into high, medium, and low five-year R&D growth minus five-year earnings momentum, $RDG(5) - EM(5)$, portfolios, and then, within each of those portfolios, into high, medium, and low *RDS* portfolios. We expect (Proposition 2) that when $RDG(5)$ is larger than reported $EM(5)$, the latter will be smaller than $EM(5)^C$, and vice versa for $RDG(5) < EM(5)$. This indeed is the case in the high $RDG(5) - EM(5)$ and the high *RDS* portfolio (left-most column), where the mean five-year R&D growth $RDG(5)$ of 3.157 (315.7 percent over five years) is substantially larger than the mean reported five-year earnings change $EM(5)$ of −9.713, which in turn is smaller (conservative reporting) than R&D-capitalized earnings momentum, $EM(5)^C$, of −4.345. In the case of low $RDG(5) - EM(5)$ and medium *RDS* portfolio (second from the right-most column), the mean five-year R&D growth of 0.436 (43.6 percent over five years) is substantially lower than the mean reported five-year earnings change $EM(5)$ of 17.638, which in turn is larger (aggressive reporting) than the five-year earnings change under R&D capitalization of 7.246. Thus, our model's predictions regarding the cutoff rates for conservative/aggressive reporting of earnings growth and ROE are validated by the data.

The data in panel A of Table 4 show that, for all sample firms, the differences between the mean *reported* earnings momentum and the momentum under R&D *capitalization* are in all but one portfolio in the expected direction (the Medium $RDG(5) - EM(5)$ – high *RDS* is in the opposite direction, perhaps due to outliers). Median values (reported in square brackets) exhibit similar patterns to the means. Although mean and median patterns are consistent with Hypothesis 2 (2R), the mean differences between reported and R&D-capitalized earnings changes (reported in the row labeled Reported earnings momentum minus R&D-capitalized earnings momentum) are not significant in any of the nine portfolios (Fama-MacBeth 1973 *t*-statistics in parentheses). However, seven out of the nine median differences between reported and R&D-capitalized earnings changes are significant. These significance tests imply that there is high variability in the yearly mean differences between reported and R&D-capitalized earnings changes that renders the *t*-statistics insignificant.[18]

One way to reduce the variability in the mean differences is to consider only firms with positive earnings after adjusting for R&D capitalization. The results from such a subsample are reported in panel B of Table 4. Clearly, all nine median differences between reported and R&D-capitalized earnings changes are now highly significant. In addition, four out of nine mean differences are significant at the 1 percent level and one at the 10 percent level. The most significant mean and median differences are for the high R&D growth minus earnings momentum portfolios (first three columns). A comparison of panels A and B of Table 4 reveals that the firms of panel B are much larger in size and more stable (larger $B/M$ and $E/P$ ratios) than the firms of panel A. In addition, a comparison of Tables 3 and 4 reveals that mean and median differences between reported and R&D-capitalized earnings momentum, given R&D growth and R&D intensity (Table 4), are larger than the differences between reported and R&D-capitalized ROE (Table 3). The reason apparently lies in the larger effect of R&D capitalization on a change indicator (*earnings momentum*) than on a levels measure (*ROE*). Evidently, the cross-sectional variability of the earnings momentum bias is larger than that of the ROE bias.[19]

Summarizing, our analyses validate the predictions of our propositions and provide empirical support for the related Hypotheses 1 (1R) and 2 (2R): differences between R&D growth rates and key profitability measures (*earnings momentum* and *ROE*) lead to systematic reporting biases in the profitability measures. In

TABLE 4

Earnings change (momentum) biases: Reported versus R&D-capitalized momentum values

**Panel A:** All sample firms (all NYSE, AMEX, and NASDAQ firms with coverage on the COMPUSTAT and CRSP files, consisting of 32,660 firm-year observations)

| R&D growth minus earnings momentum | High | | | Medium | | | Low | | |
|---|---|---|---|---|---|---|---|---|---|
| R&D-to-sales (*RDS*) | High | Medium | Low | High | Medium | Low | High | Medium | Low |
| R&D growth (*RDG*(5)) | 3.157 | 2.584 | 1.790 | 0.648 | 0.486 | 0.306 | 0.732 | 0.436 | 0.100 |
| | [1.427] | [0.991] | [0.706] | [0.503] | [0.390] | [0.244] | [0.292] | [0.211] | [0.007] |
| R&D growth minus earnings momentum | 12.870 | 11.331 | 7.496 | 0.308 | 0.278 | 0.237 | −8.143 | −17.202 | −15.586 |
| | [3.544] | [2.665] | [2.342] | [0.307] | [0.266] | [0.204] | [−1.529] | [−1.602] | [−1.531] |
| R&D-to-sales (*RDS*) | 3.081 | 0.075 | 0.018 | 2.055 | 0.035 | 0.009 | 1.122 | 0.039 | 0.009 |
| | [0.246] | [0.072] | [0.016] | [0.111] | [0.033] | [0.009] | [0.112] | [0.037] | [0.008] |
| Reported earnings momentum (*EM*(5)) | −9.713 | −8.747 | −5.705 | 0.340 | 0.208 | 0.069 | 8.875 | 17.638 | 15.686 |
| | [−1.830] | [−1.339] | [−1.334] | [0.232] | [0.153] | [0.055] | [1.940] | [1.812] | [1.557] |
| R&D-capitalized earnings momentum ($EM(5)^C$) | −4.345 | −6.911 | −5.159 | 0.148 | 0.549 | 0.073 | 7.198 | 7.246 | 14.661 |
| | [−0.869] | [−0.825] | [−1.129] | [0.257] | [0.151] | [0.054] | [1.428] | [1.520] | [1.414] |
| Reported earnings momentum minus R&D-capitalized earnings momentum ($EM(5) - EM(5)^C$) | −5.368 | −1.835 | −0.547 | 0.192 | −0.342 | −0.004 | 1.677 | 10.392 | 1.026 |
| | (−2.009) | (−0.645) | (−0.850) | (0.379) | (−1.427) | (−0.115) | (1.060) | (1.194) | (0.370) |
| | [−0.872] | [−0.479] | [−0.126] | [0.013] | [0.011] | [0.008] | [0.337] | [0.203] | [0.078] |
| | (−13.480) | (−9.045) | (−9.315) | (1.013) | (1.844) | (4.392) | (8.987) | (12.033) | (13.601) |
| Book-to-market | 0.493 | 0.713 | 0.737 | 0.502 | 0.650 | 0.746 | 0.387 | 0.586 | 0.651 |
| | [0.429] | [0.670] | [0.784] | [0.433] | [0.589] | [0.701] | [0.377] | [0.531] | [0.608] |

(The table is continued on the next page.)

TABLE 4 (Continued)

**Panel A** (Continued)

| R&D growth minus earnings momentum | High | | | Medium | | | Low | | |
|---|---|---|---|---|---|---|---|---|---|
| R&D-to-sales (*RDS*) | High | Medium | Low | High | Medium | Low | High | Medium | Low |
| Earnings-to-price | −0.311 | −0.349 | −0.412 | −0.105 | −0.001 | −0.014 | −0.049 | 0.010 | 0.037 |
| | [−0.075] | [−0.020] | [−0.035] | [0.036] | [0.066] | [0.073] | [0.038] | [0.072] | [0.085] |
| Market capitalization | 740 | 1,411 | 1,136 | 4,129 | 2,757 | 4,022 | 1,787 | 2,205 | 2,659 |
| ($ millions) | [68] | [70] | [64] | [170] | [308] | [401] | [83] | [117] | [151] |

**Panel B:** Sample firms with positive R&D-capitalized earnings (all NYSE, AMEX, and NASDAQ firms with positive R&D-capitalized earnings at $t$ and $t-4$, and with coverage on the COMPUSTAT and CRSP files, consisting of 18,577 firm-year observations)

| R&D growth minus earnings momentum | High | | | Medium | | | Low | | |
|---|---|---|---|---|---|---|---|---|---|
| R&D-to-sales (*RDS*) | High | Medium | Low | High | Medium | Low | High | Medium | Low |
| R&D growth (*RDG*(5)) | 3.817 | 2.256 | 1.795 | 0.724 | 0.433 | 0.273 | 1.178 | 0.539 | 0.167 |
| | [1.515] | [1.044] | [0.984] | [0.568] | [0.351] | [0.228] | [0.731] | [0.315] | [0.086] |
| R&D growth minus earnings | 4.856 | 2.447 | 1.832 | 0.122 | 0.095 | 0.073 | −11.299 | −9.381 | −14.671 |
| momentum | [1.741] | [1.220] | [1.086] | [0.143] | [0.097] | [0.068] | [−2.120] | [−1.434] | [−1.305] |
| R&D-to-sales (*RDS*) | 0.155 | 0.047 | 0.013 | 0.085 | 0.027 | 0.008 | 0.103 | 0.030 | 0.007 |
| | [0.122] | [0.046] | [0.013] | [0.071] | [0.026] | [0.008] | [0.087] | [0.029] | [0.007] |
| Reported earnings momentum | −1.039 | −0.190 | −0.037 | 0.601 | 0.338 | 0.200 | 12.477 | 9.920 | 14.838 |
| (*EM*(5)) | [−0.343] | [−0.256] | [−0.236] | [0.476] | [0.283] | [0.141] | [3.161] | [1.848] | [1.541] |

(The table is continued on the next page.)

TABLE 4 (Continued)

| **Panel B** (Continued)<br>R&D growth minus earnings momentum | High | | | Medium | | | Low | | |
|---|---|---|---|---|---|---|---|---|---|
| R&D-to-sales (*RDS*) | High | Medium | Low | High | Medium | Low | High | Medium | Low |
| R&D-capitalized earnings | 1.334 | 1.203 | 0.235 | 1.177 | 0.411 | 0.209 | 8.107 | 6.759 | 14.914 |
| momentum ($EM(5)^C$) | [0.205] | [−0.022] | [−0.145] | [0.416] | [0.238] | [0.145] | [1.968] | [1.453] | [1.383] |
| Reported earnings momentum | −2.373 | −1.393 | −0.272 | −0.576 | −0.073 | −0.009 | 4.371 | 3.161 | −0.077 |
| minus R&D-capitalized | (−3.823) | (−3.680) | (−5.999) | (−1.576) | (−1.782) | (−1.369) | (2.677) | (1.947) | (−0.024) |
| earnings momentum | [−0.460] | [−0.174] | [−0.059] | [0.051] | [0.031] | [0.012] | [0.854] | [0.334] | [0.096] |
| ($EM(5) - EM(5)^C$) | (−12.545) | (−19.974) | (−13.895) | (3.923) | (4.805) | (6.693) | (8.232) | (9.440) | (9.641) |
| Book-to-market | 0.608 | 0.243 | 0.777 | 0.258 | 0.635 | 0.641 | 0.473 | 0.615 | 0.663 |
| | [0.529] | [0.676] | [0.744] | [0.448] | [0.585] | [0.673] | [0.403] | [0.536] | [0.590] |
| Earnings-to-price | 0.025 | 0.086 | 0.065 | 0.068 | 0.081 | 0.086 | 0.071 | 0.093 | 0.109 |
| | [0.033] | [0.050] | [0.062] | [0.062] | [0.075] | [0.079] | [0.059] | [0.082] | [0.089] |
| Market capitalization | 3,503 | 2,271 | 1,948 | 8,146 | 3,611 | 5,084 | 3,972 | 3,131 | 4,552 |
| ($ millions) | [284] | [193] | [280] | [840] | [590] | [565] | [378] | [323] | [361] |

(The table is continued on the next page.)

TABLE 4 (Continued)

**Notes:**

In each year from 1979 to 2003, sample firms are ranked by R&D growth minus earnings momentum, and assigned into one of three equally sized R&D growth portfolios. Each R&D growth portfolio is then subdivided into three equally sized R&D intensity portfolios by ranking on R&D-to-sales (*RDS*). Values in the table are means of yearly portfolio means and, in square brackets, means of yearly portfolio medians of various variables over the 25-year period 1979–2003. Numbers in parentheses are Fama-MacBeth *t*-statistics calculated using the 25-yearly mean values.

R&D growth equals $[(RD_t - RD_{t-4})/RD_{t-4}]$, where *RD* is R&D expenditures (COMPUSTAT item no. 46). Reported earnings momentum equals $(earnings_t - earnings_{t-4})/|earnings_{t-4}|$, where $earnings_t$ is COMPUSTAT item no. 172. R&D-capitalized earnings momentum equals $(adjusted\ earnings_t - adjusted\ earnings_{t-4})/|adjusted\ earnings_{t-4})|$. $Adjusted\ earnings_t$ equals $reported\ earnings_t$ plus $R\&D\ expenditures_t$ minus $R\&D\ amortization_t$. $R\&D\ amortization_t$ equals $0.2^*(RD_{it-1} + RD_{it-2} + RD_{it-3} + RD_{it-4} + RD_{it-5})$. Book-to-market, earnings-to-price, and market capitalization are computed as of the fiscal year-end. R&D-to-sales equals COMPUSTAT item no. 46 divided by COMPUSTAT item no. 12.

general, companies with high R&D growth rates relative to their profitability (often emerging industries, such as biotech, and young companies), report conservatively, while low R&D growth companies (mature firms) report aggressively. The analysis also indicates that the reporting biases are substantially larger for the earnings momentum than for the return on equity. Thus, the widely held view that the expensing of intangible investments generally leads to conservative profitability reporting is a misconception. At the same time, the analysis reveals that the reporting bias in both ROE and earnings momentum is statistically significant. We now turn to the question what, if any, are the effects of reporting biases (conservative/aggressive reporting) on investors' valuations.

## 5. The valuation consequences of reporting biases

### *Methodology*

In this section we examine Hypotheses 3 and 4 — namely, whether the reporting biases lead to stock market misvaluations. As mentioned above, behavioral finance theory predicts that misvaluations will take place if investors fixate on the relationship between reported profitability and R&D growth and see a trend in that relationship. Corrections of any misvaluations will take place when the trend in the relationship alters because investors notice the change and take the appropriate action that corrects the misvaluation. Thus both hypotheses predict significant abnormal returns reversals when the bias-driving variable reverses sign. To test these hypotheses, we employ the following methodology. In each sample year, we select firms for which the bias driving variable reverses from positive in year $t-1$ to negative in year $t$, and from negative in year $t-1$ to positive in year $t$ and form three portfolios: (1) "positive to negative reversal" portfolio, (2) "negative to positive reversal" portfolio, and (3) "nonreversal" portfolio (the remaining firms in the sample). We trace these firms back five years before the reversal to capture any trends as the theory suggests, and one year after the reversal. For each of these seven years and for each portfolio, we compute descriptive statistics and calculate annual raw and abnormal returns. These annual returns are for the year following the disclosure of the financial statements (the returns calculation starts from the seventh month after fiscal year-end). The abnormal returns are the residuals from the following cross-sectional regression:

$$\begin{aligned} R_{i,j+1} = {} & c_{0,j} + c_{1,j}\beta_{i,j} + c_{2,j}\ln(M)_{i,j} + c_{3,j}\ln(B/M)_{i,j} + c_{4,j}\ln(A/B)_{i,j} \\ & + c_{5,j}[E(+)/M]_{i,j} + c_{6,j}(E/M\text{ dummy})_{i,j} + c_{7,j}\ln(RDC/M)_{i,j} \\ & + c_{8,j}R_{i,j} + e_{i,j+1} \end{aligned} \qquad (3).$$

In (3), $i$ denotes a sample firm and $j$ denotes the year relative to the reporting bias reversal year $t$ — that is, $j = t - 5, t - 4, t - 3, t - 2, t - 1, t$, and $t + 1$. The variables in (3) are defined as follows.

$R_{i,j+1}$ = *returns*: one-year-ahead stock returns of firm $i$, starting with the seventh month after fiscal year $j$ year-end;

$\beta_{i,j}$ = *risk*: CAPM-based beta of firm $i$, estimated from 60 monthly stock returns up to one month preceding the one-year-ahead return calculation at $j$; a minimum of 24 months is required;

$M_{i,j}$ = *size*: market value of firm $i$, calculated as price times number of shares outstanding at $j$, the beginning of the one-year-ahead returns calculation period;

$(B/M)_{i,j}$ = *book-to-market*: ratio of book value of common equity (COMPUSTAT item no. 60) plus balance sheet deferred taxes (COMPUSTAT item no. 74) to market value of equity of firm $i$ at fiscal year $j$ year-end (COMPUSTAT item no. 199 times COMPUSTAT item no. 25);

$(A/B)_{i,j}$ = *leverage*: ratio of book value of total assets (COMPUSTAT item no. 6) to book value of common equity of firm $i$ at fiscal year $j$ year-end;

$[E(+)/M]_{i,j}$ = *earnings-to-price ratio*: ratio of positive earnings before extraordinary items (COMPUSTAT item no. 172) plus income statement deferred taxes (COMPUSTAT item no. 50) minus preferred dividends (COMPUSTAT item no. 19), to market value of common equity of firm $i$ at fiscal year $j$ year-end; this variable is set equal to 0 when earnings are negative;

$(E/M\text{ dummy})_{i,j}$ = 1 if earnings of firm $i$ for fiscal year $j$ are negative, and 0 otherwise;

$(RDC/M)_{i,j}$ = *R&D capital:* ratio of estimated R&D capital (2) over market value of equity at fiscal year $j$ year-end;

$R_{i,j}$ = *past return:* stock return over the six-month period leading up to the seventh month after fiscal year $j$ year-end.

The advantage of calculating abnormal returns using (3) is that it allows us to control for various well-known risk factors (beta, size, book-to-market ratio, momentum) including R&D. We based (3) on Fama and French 1992, who regressed stock returns on lagged values of the following fundamentals: systematic risk ($\beta$), firm size (market capitalization), book-to-market ratio, financial leverage, and earnings-to-price ratio. It also controls for price momentum, documented by Jegadeesh and Titman 1993, among others, by including the returns for the six months before portfolio formation. In addition, it includes an R&D intensity measure — the R&D capital-to-market ratio — because Lev and Sougiannis (1996), among others, found it to significantly correlate with future stock returns. Obviously, controlling for the R&D intensity effect is important in isolating a reporting bias effect.[20]

***Empirical results: ROE biases***

For the case of ROE reporting biases, in each sample year we select firms for which the difference ($\{RDG/[(RDG/2) + 1]\} - ROE$) reverses and form the "positive to negative reversal" portfolio, the "negative to positive reversal" portfolio, and the "nonreversal" portfolio.

Table 5 reports the results from this portfolio analysis. Panel A presents the results for the "positive to negative reversal" portfolio. The bias-driving variable, *R&D growth − ROE*, reported in the first row of the panel shows a strong pattern: for the five years prior to the reversal, the bias is consistently positive and even monotonically increases, then it reverses by a substantial amount and remains negative but small at $t + 1$. Thus, the bias builds up to a significant positive value (that is, it shows a strong trend) before it reverses to a negative value, and it takes, on average, six years to reverse. Recall that the prediction for this portfolio is to be undervalued, given the presence of conservative accounting.

Clearly, both raw and abnormal one-year-ahead stock returns, reported in the second and third rows of panel A, peak in the year of the reversal. (Note that reported returns are for the year following the disclosure of the financial statements — namely, returns reported for year $t - 1$ are actually returns earned in year $t$.) Thus, raw and abnormal returns in year $t$ rise to 34.9 percent and 10.9 percent, respectively, and then decline, suggesting that a correction takes place. In particular, the abnormal returns pattern is consistent with an initial undervaluation of this portfolio. Thus, the abnormal returns are significantly negative in the three early years, −8.7 percent, −9.7 percent, −13.7 percent, with corresponding Fama-MacBeth $t$-statistics of −10.141, −9.312, and −9.203. However, they are not statistically different from zero in the year before the reversal (3.0 percent, $t$-statistic 1.936), significantly positive in the year of the reversal (10.9 percent, $t$-statistic 7.272), and not significantly different from zero in the two years after the reversal (0.7 percent,

−1.6 percent, with corresponding *t*-statistics of 0.536 and −1.553). Overall, for this portfolio, there is strong evidence of a trend in *R&D growth − ROE* and of an initial undervaluation with subsequent correction when the trend in *R&D growth − ROE* alters.

The remaining data reported in the panel identify the characteristics of the firms in this portfolio. On average, about 147 firms have positive to negative reversals per year during our sample period. Their mean size (market capitalization) is somewhat above $1 billion, systematic risk (beta) is well above the market's average risk, and they are growth firms ($E/P$ and $B/M$ ratios below normal). These firms allocate about 10 percent of their sales revenues to R&D (R&D-to-sales) and their R&D growth rate is particularly strong in the five years before the reversal. This strong R&D growth rate leads to an accounting conservative bias (consistent with the above analysis), as evident in the comparison of reported ROE and adjusted (R&D-capitalized) ROE: for the five years before the reversal, reported ROE is consistently less than adjusted ROE, while in the year of the reversal and the subsequent one, the opposite holds.

Panel B reports the findings for the "negative to positive reversal" portfolio. The bias-driving variable, *R&D growth − R&D*, shows a declining pattern reaching a large negative value in year $t-1$ (−0.279) and reversing to a large positive value in year $t$ (0.263). Unlike the previous case, the bias in this portfolio reverses in a shorter period of time — namely, three years. Thus, in panel B we see two bias reversals: one from positive to negative at $t-2$ not by construction, and another from negative to positive at $t$ by construction. That is, over the seven-year horizon, these firms turn from conservative to aggressive accounting and then back again to conservative accounting. The abnormal returns pattern in years $t-4$ to $t-2$ is similar to that in panel A — namely, abnormal returns in year $t-2$ rise to 10.5 percent with a *t*-statistic of 8.728 and then decline. However, the abnormal returns pattern in years $t-2$ to $t$ is opposite — that is, abnormal returns in year $t$ decline to −7.6 percent with a *t*-statistic of −8.234 and then increase. Taken together, the significantly positive abnormal returns in years $t-3$ (3.2 percent, *t*-statistic 2.871) and $t-2$ (10.5 percent, *t*-statistic 8.728) are offset by the significantly negative abnormal returns in years $t$ (−7.6 percent, *t*-statistic −8.234) and $t+1$ (−2.5 percent, *t*-statistic −2.443).[21] This evidence of significant abnormal returns reversals at the time of ROE bias reversals is consistent with mispricing also taking place in this portfolio. In addition, the shorter period of the bias reversal in panel B relative to panel A implies that aggressive accounting persists over a shorter period than conservative accounting.[22]

The remaining data in panel B indicate that, on average, about 154 firms have such reversals per year over the sample period. These firms are slightly smaller in size, are more profitable, and have lower R&D growth than firms in panel A. Again, the comparison of reported ROE and adjusted ROE is consistent with the presence of conservative accounting when *R&D growth − ROE* is positive and, with the presence of aggressive accounting, when *R&D growth − ROE* is negative.

Panel C reports the results for the "nonreversal" portfolio. Most of the sample firms belong to this portfolio. The bias-driving variable has consistently large positive

TABLE 5
ROE bias reversal analysis

**Panel A:** "Positive to negative reversal" portfolio

| | Years relative to the reversal year *t* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *t* – 5 | *t* – 4 | *t* – 3 | *t* – 2 | *t* – 1 | *t* | *t* + 1 |
| *R&D growth – ROE* | 0.119 | 0.180 | 0.183 | 0.185 | 0.304 | –0.136 | –0.006 |
| Raw returns | 0.143 | 0.127 | 0.086 | 0.281 | 0.349 | 0.195 | 0.175 |
| Abnormal returns | –0.087 | –0.097 | –0.137 | 0.030 | 0.109 | 0.007 | –0.016 |
| *t*-statistics | (–10.141) | (–9.312) | (–9.203) | (1.936) | (7.272) | (0.536) | (–1.553) |
| R&D growth rate | 0.196 | 0.242 | 0.230 | 0.201 | 0.166 | 0.016 | 0.065 |
| Reported ROE | 0.076 | 0.062 | 0.047 | 0.016 | –0.138 | 0.152 | 0.071 |
| R&D-capitalized ROE | 0.092 | 0.091 | 0.063 | 0.043 | –0.022 | 0.096 | 0.063 |
| R&D-to-sales | 0.079 | 0.151 | 0.098 | 0.091 | 0.130 | 0.063 | 0.143 |
| Earnings-to-price | 0.079 | 0.074 | 0.064 | 0.057 | 0.039 | 0.074 | 0.061 |
| Book-to-market | 0.826 | 0.815 | 0.822 | 0.833 | 0.771 | 0.731 | 0.713 |
| Beta | 1.244 | 1.216 | 1.201 | 1.183 | 1.176 | 1.142 | 1.132 |
| Market capitalization | 952 | 1,004 | 1,007 | 1,057 | 1,315 | 1,382 | 1,571 |
| Number of firms | 106 | 115 | 126 | 134 | 147 | 147 | 134 |

(The table is continued on the next page.)

TABLE 5 (Continued)

**Panel B:** "Negative to positive reversal" portfolio

| | Years relative to the reversal year *t* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *t* − 5 | *t* − 4 | *t* − 3 | *t* − 2 | *t* − 1 | *t* | *t* + 1 |
| *R&D growth – ROE* | 0.144 | 0.090 | 0.046 | −0.006 | 0.279 | 0.263 | 0.210 |
| Raw returns | 0.229 | 0.279 | 0.327 | 0.204 | 0.126 | 0.154 | 0.216 |
| Abnormal returns | −0.015 | 0.032 | 0.105 | −0.028 | −0.076 | −0.025 | 0.021 |
| *t*-statistics | (−1.542) | (2.871) | (8.728) | (−1.927) | (−8.234) | (−2.443) | (1.603) |
| R&D growth rate | 0.189 | 0.119 | 0.086 | 0.056 | 0.023 | 0.212 | 0.214 |
| Reported ROE | 0.045 | 0.029 | 0.041 | 0.061 | 0.302 | −0.051 | 0.004 |
| R&D-capitalized ROE | 0.062 | 0.047 | 0.053 | 0.057 | 0.094 | −0.000 | 0.042 |
| R&D-to-sales | 0.088 | 0.074 | 0.069 | 0.078 | 0.079 | 0.128 | 0.087 |
| Earnings-to-price | 0.071 | 0.070 | 0.068 | 0.069 | 0.074 | 0.042 | 0.049 |
| Book-to-market | 0.893 | 0.863 | 0.795 | 0.729 | 0.699 | 0.736 | 0.749 |
| Beta | 1.211 | 1.189 | 1.186 | 1.198 | 1.185 | 1.164 | 1.150 |
| Market capitalization | 831 | 904 | 1,033 | 1,155 | 1,211 | 1,302 | 1,523 |
| Number of firms | 99 | 110 | 119 | 135 | 154 | 154 | 139 |

(The table is continued on the next page.)

TABLE 5 (Continued)

**Panel C:** "Nonreversal" portfolio

| | Years relative to the reversal year *t* | | | | | | |
|---|---|---|---|---|---|---|---|
| | $t-5$ | $t-4$ | $t-3$ | $t-2$ | $t-1$ | $t$ | $t+1$ |
| *R&D growth – ROE* | 0.101 | 0.132 | 0.140 | 0.170 | 0.234 | 0.238 | 0.200 |
| Raw returns | 0.236 | 0.227 | 0.213 | 0.226 | 0.208 | 0.181 | 0.185 |
| Abnormal returns | 0.018 | 0.011 | 0.007 | −0.002 | −0.004 | 0.003 | −0.002 |
| *t*-statistics | (7.348) | (3.770) | (2.889) | (−0.646) | (−1.097) | (0.917) | (−0.793) |
| R&D growth rate | 0.193 | 0.200 | 0.210 | 0.223 | 0.236 | 0.219 | 0.196 |
| Reported ROE | 0.092 | 0.068 | 0.070 | 0.054 | 0.002 | −0.018 | −0.004 |
| R&D-capitalized ROE | 0.089 | 0.087 | 0.083 | 0.074 | 0.060 | 0.044 | 0.047 |
| R&D-to-sales | 0.413 | 0.428 | 0.498 | 0.530 | 0.637 | 0.587 | 0.484 |
| Earnings-to-price | 0.074 | 0.070 | 0.066 | 0.061 | 0.057 | 0.053 | 0.051 |
| Book-to-market | 0.773 | 0.730 | 0.705 | 0.687 | 0.674 | 0.676 | 0.670 |
| Beta | 1.222 | 1.227 | 1.223 | 1.223 | 1.222 | 1.197 | 1.174 |
| Market capitalization | 1,376 | 1,450 | 1,538 | 1,651 | 1,784 | 2,039 | 2,429 |
| Number of firms | 611 | 671 | 738 | 820 | 924 | 926 | 842 |

(The table is continued on the next page.)

TABLE 5 (Continued)

**Notes:**

In each year from 1975 to 2000, we detect firms for which the difference $\{RDG/[(RDG/2)+1]\} - ROE$ reverses. For example, for 1980, we detect firms that had $\{RDG/[(RDG/2)+1]\} - ROE > 0$ in 1979 but $< 0$ in 1980. This is our "positive to negative reversal" portfolio. We also detect firms that had $\{RDG/[(RDG/2)+1]\} - ROE < 0$ in 1979 but $> 0$ in 1980. This is our "negative to positive reversal" portfolio. The remaining firms comprise the "nonreversal" portfolio. We trace these firms five years before and one year after the reversal year. For each of these seven years and for each portfolio, we report mean values of key characteristics including annual raw and abnormal returns. These returns are for the year following the disclosure of the financial statements — that is, we start the annual return calculation from the seventh month after fiscal year-end. The abnormal returns are the residuals from the cross-sectional regression:

$$R_{i,j+1} = c_{0,j} + c_{1,j}\beta_{i,j} + c_{2,j}\ln(M)_{i,j} + c_{3,j}\ln(B/M)_{i,j} + c_{4,j}\ln(A/B)_{i,j} + c_{5,j}[E(+)/M]_{i,j} + c_{6,j}(E/M\text{ dummy})_{i,j} + c_{7,j}\ln(RDC/M)_{i,j} + c_{8,j}R_{i,j} + e_{i,j+1},$$

where $j$ denotes the year relative to the reversal year $t$ — that is, $j = t-5, t-4, t-3, t-2, t-1, t$, and $t+1$. (See variable definitions below.) We run this regression each year for all firms and we report the mean of the yearly mean residuals and in parentheses their Fama-MacBeth $t$-statistics for the firms that belong to each portfolio.

$R_{i,j+1}$ is the one-year-ahead stock return starting with the seventh month after fiscal year $j$ year-end.

$\beta_{i,j}$ is the capital asset pricing model (CAPM)-based beta estimated from 60 monthly stock returns up to one month preceding the one-year-ahead return calculation at $j$.

$M_{i,j}$ is firm market value calculated as price times number of shares outstanding at $j$, the beginning of the one-year-ahead returns calculation period.

$(B/M)_{i,j}$ is book-to-market ratio at fiscal year $j$ year-end.

$(A/B)_{i,j}$ is the ratio of book value of total assets to book value of common equity at fiscal year $j$ year-end.

$[E(+)/M]_{i,j}$ is the ratio of positive earnings to the market value of equity at fiscal year $j$ year-end and is equal to 0 when earnings are negative.

$(E/M\text{ dummy})_{i,j}$ equals 1 if earnings for fiscal year $j$ are negative and 0 otherwise.

$(RDC/M)_{i,j}$ is the estimated R&D capital-to-market value of equity ratio at fiscal year $j$ year-end.

$R_{i,j}$ is the stock return over the six-month period leading up to the seventh month after fiscal year $j$ year-end.

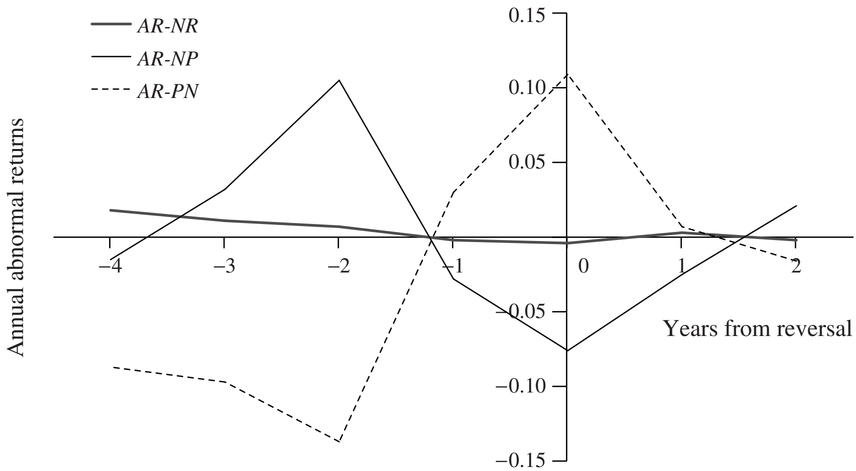
values, similar to those of the "positive to negative reversal" portfolio. Unlike the other two portfolios, there is, however, no specific pattern in stock returns. Raw and abnormal returns stay around 20 percent and 0 percent over the seven-year horizon, respectively.[23] This result increases our confidence that the patterns observed in the two portfolios described above reflect mispricing and its correction. It is also important to note that the yearly mean returns (not reported), especially the abnormal returns, are remarkably consistent with the all-years mean returns for each portfolio reported in Table 5. Thus, the returns results are systematic and not driven by extreme values.

We summarize this portfolio analysis by plotting the average annual abnormal returns (*AR*) for each of the portfolios over the seven-year horizon. Figure 1 shows the three lines: *AR-NR* for the "nonreversal" portfolio, *AR-PN* for the "positive to negative reversal" portfolio, and *AR-NP* for the "negative to positive reversal" portfolio. Clearly, the *AR-NR* line is flat and close to zero. However, *AR-NP* and *AR-PN* show patterns consistent with overvaluation and undervaluation, respectively. *AR-NP* starts negative, increases to about 10 percent, then declines to −8 percent, and converges to 0 percent by $t + 2$, indicating correction of the overvaluation. *AR-PN* starts negative, declines further to about −14 percent, then reverses to about 11 percent, and also converges to 0 percent by $t + 2$, indicating correction of the undervaluation. Overall, these portfolio results provide substantial support for Hypothesis 3.

***Empirical results: Momentum bias***

Table 6 reports results for portfolios formed on the basis of the earnings momentum bias reversals. Thus, in each sample year we select firms for which the difference $RDG(5)_{it} - EM(5)_{it}$ reverses. We form three portfolios: (1) "positive to negative reversal" portfolio, (2) "negative to positive reversal" portfolio, and (3) "nonreversal" portfolio (the remaining firms in the sample). We trace these firms five years before and one year after the reversal year. Panel A reports the results for the "positive to negative reversal" portfolio. The bias-driving variable, *R&D growth – EM*, reverses within a five-year period (positive from $t - 4$ to $t - 1$ and reverses to negative at $t$). The expectation for this portfolio is to be undervalued given the presence of conservative accounting. Indeed, both raw and abnormal one-year-ahead stock returns, reported in the second and third rows of the panel, peak in the year of the reversal. (Note again that reported returns are for the year following the disclosure of the financial statements — that is, returns reported for year $t - 1$ are returns earned in year $t$.) Thus, raw and abnormal returns in year $t$ rise to 33 percent and 12 percent, respectively, and then decline, suggesting that a correction takes place. In particular, the abnormal returns pattern is consistent with an undervaluation of this portfolio. Thus, the abnormal returns are significantly negative in the three early years, −9.6 percent, −6 percent, −6 percent, with corresponding Fama-MacBeth $t$-statistics of −7.891, −4.364, and −3.421. They are, however, statistically positive in the year before the reversal (4.9 percent, $t$-statistic 2.752), and especially in the year of the reversal (12 percent, $t$-statistic 7.032), and are not significantly different from zero in the year after the reversal (−0.1 percent, $t$-statistic −0.070).

**Figure 1** ROE bias reversal analysis




**Notes:**

Annual abnormal returns ($AR$) are plotted for three portfolios formed on the basis of ROE bias reversals. In each year from 1975 to 2000, we detect firms for which the difference $\{RDG/[(RDG/2) + 1]\} - ROE$ reverses. For example, for 1980, we detect firms that had $\{RDG/[(RDG/2) + 1]\} - ROE > 0$ in 1979 but $< 0$ in 1980. This is our "positive to negative reversal" ($PN$) portfolio. We also detect firms that had $\{RDG/[(RDG/2) + 1]\} - ROE > 0$ in 1979 but $> 0$ in 1980. This is our "negative to positive reversal" ($NP$) portfolio. The remaining firms comprise the "nonreversal" ($NR$) portfolio. We trace these firms five years before and one year after the reversal year. For each of these seven years and for each portfolio, we calculate annual abnormal returns using the residuals of the following cross-sectional regression:

$$R_{i,j+1} = c_{0,j} + c_{1,j}\beta_{i,j} + c_{2,j}\ln(M)_{i,j} + c_{3,j}\ln(B/M)_{i,j} + c_{4,j}\ln(A/B)_{i,j} + c_{5,j}[E(+)/M]_{i,j} + c_{6,j}(E/M \text{ dummy})_{i,j} + c_{7,j}\ln(RDC/M)_{i,j} + c_{8,j}R_{i,j} + e_{i,j+1},$$

where $j$ denotes the year relative to the reversal year $t$ — that is, $j = t - 5, t - 4, t - 3, t - 2, t - 1, t$, and $t + 1$. These returns are for the year following the disclosure of the financial statements — that is, we start the annual return calculation from the seventh month after fiscal year-end. $R_{i,j+1}$ is one-year-ahead stock return starting with the seventh month after fiscal year $j$ year-end; $\beta_{i,j}$ is the CAPM-based beta estimated from 60 monthly stock returns up to one month preceding the one-year-ahead return calculation at $j$; $M_{i,j}$ is firm market value calculated as price times number of shares outstanding at $j$, the beginning of the one-year-ahead returns calculation period; $(B/M)_{i,j}$ is book-to-market ratio at fiscal year $j$ year-end; $(A/B)_{i,j}$ is the ratio of book value of total assets to book value of common equity at fiscal year $j$ year-end; $[E(+)/M]_{i,j}$ is the ratio of positive earnings to the market value of equity at fiscal year $j$ year-end and is equal to 0 when earnings are negative; $(E/M \text{ dummy})_{i,j}$ equals 1 if earnings for fiscal year $j$ are negative and 0 otherwise; $(RDC/M)_{i,j}$ is the estimated R&D capital-to-market value of equity at fiscal year $j$ year-end; and $R_{i,j}$ is the stock return over the six-month period leading up to the seventh month after fiscal year $j$ year-end.

TABLE 6
Earnings momentum bias reversal analysis

**Panel A:** "Positive to negative reversal" portfolio

| | Years relative to the reversal year *t* | | | | | | |
|---|---|---|---|---|---|---|---|
| | $t-5$ | $t-4$ | $t-3$ | $t-2$ | $t-1$ | $t$ | $t+1$ |
| *R&D growth – EM* | −1.083 | 1.380 | 1.309 | 1.050 | 3.043 | −3.475 | −1.580 |
| Raw returns | 0.126 | 0.150 | 0.165 | 0.272 | 0.330 | 0.176 | 0.146 |
| Abnormal returns | −0.096 | −0.060 | −0.060 | 0.049 | 0.120 | −0.001 | −0.027 |
| *t*-statistics | (−7.891) | (−4.364) | (−3.421) | (2.752) | (7.032) | (−0.070) | (−2.847) |
| R&D growth rate | 1.247 | 1.361 | 1.072 | 1.033 | 0.982 | 0.444 | 0.634 |
| Earnings momentum (*EM*) | 2.330 | −0.019 | −0.237 | −0.018 | −2.061 | 3.920 | 2.214 |
| R&D-capitalized EM | 2.160 | 0.895 | 0.373 | 0.245 | −1.188 | 3.159 | 2.164 |
| R&D-to-sales | 0.076 | 0.217 | 0.139 | 0.132 | 0.263 | 0.134 | 0.201 |
| Earnings-to-price | 0.077 | 0.047 | 0.049 | 0.046 | 0.035 | 0.069 | 0.056 |
| Book-to-price | 0.765 | 0.795 | 0.770 | 0.735 | 0.691 | 0.643 | 0.657 |
| Beta | 1.171 | 1.154 | 1.142 | 1.115 | 1.101 | 1.080 | 1.085 |
| Market capitalization | 1,597 | 741 | 1,826 | 1,956 | 2,275 | 2,740 | 3,061 |
| Number of firms | 97 | 106 | 116 | 127 | 143 | 143 | 131 |

(The table is continued on the next page.)

TABLE 6 (Continued)

**Panel B:** "Negative to positive reversal" portfolio

| | Years relative to the reversal year *t* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *t* – 5 | *t* – 4 | *t* – 3 | *t* – 2 | *t* – 1 | *t* | *t* + 1 |
| *R&D growth – EM* | 0.556 | −0.980 | −1.444 | −1.638 | −4.243 | 3.315 | 0.486 |
| Raw returns | 0.380 | 0.228 | 0.252 | 0.125 | 0.096 | 0.182 | 0.172 |
| Abnormal returns | 0.130 | 0.020 | 0.044 | −0.069 | −0.075 | −0.005 | 0.001 |
| *t*-statistics | (6.158) | (1.603) | (1.694) | (−6.871) | (−6.282) | (−0.510) | (0.035) |
| R&D growth rate | 0.908 | 0.752 | 0.754 | 0.864 | 0.779 | 1.490 | 1.200 |
| Earnings momentum (*EM*) | 0.352 | 1.732 | 2.198 | 2.502 | 5.022 | −1.825 | −0.286 |
| R&D-capitalized EM | 0.731 | 1.788 | 2.424 | 2.522 | 4.585 | −0.438 | 0.506 |
| R&D-to-sales | 0.069 | 0.071 | 0.059 | 0.123 | 0.096 | 0.218 | 0.204 |
| Earnings-to-price | 0.054 | 0.074 | 0.065 | 0.061 | 0.069 | 0.038 | 0.045 |
| Book-to-market | 0.810 | 0.705 | 0.665 | 0.645 | 0.639 | 0.711 | 0.682 |
| Beta | 1.169 | 1.162 | 1.139 | 1.148 | 1.130 | 1.117 | 1.102 |
| Market capitalization | 1,453 | 1,684 | 1,891 | 2,042 | 2,138 | 2,428 | 2,702 |
| Number of firms | 91 | 99 | 108 | 118 | 130 | 130 | 117 |

(The table is continued on the next page.)

TABLE 6 (Continued)

**Panel C:** "Nonreversal" portfolio

| | Years relative to the reversal year *t* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *t* – 5 | *t* – 4 | *t* – 3 | *t* – 2 | *t* – 1 | *t* | *t* + 1 |
| *R&D growth – EM* | −0.130 | −0.274 | −0.153 | 0.025 | 0.222 | 0.068 | 0.019 |
| Raw returns | 0.213 | 0.209 | 0.209 | 0.202 | 0.180 | 0.182 | 0.167 |
| Abnormal returns | −0.003 | 0.010 | 0.007 | 0.004 | −0.011 | 0.002 | 0.006 |
| *t*-statistics | (−0.846) | (2.154) | (1.350) | (0.693) | (−2.506) | (0.665) | (1.446) |
| R&D growth rate | 1.105 | 1.146 | 1.156 | 1.160 | 1.172 | 0.972 | 0.904 |
| Earnings momentum (*EM*) | 1.235 | 1.420 | 1.309 | 1.135 | 0.951 | 0.905 | 0.884 |
| R&D-capitalized EM | 1.514 | 1.580 | 1.568 | 1.417 | 1.180 | 1.193 | 1.185 |
| R&D-to-sales | 0.249 | 0.326 | 0.434 | 0.465 | 0.455 | 0.447 | 0.428 |
| Earnings-to-price | 0.068 | 0.064 | 0.060 | 0.056 | 0.053 | 0.052 | 0.051 |
| Book-to-price | 0.724 | 0.697 | 0.679 | 0.662 | 0.647 | 0.656 | 0.650 |
| Beta | 1.162 | 1.159 | 1.149 | 1.143 | 1.136 | 1.115 | 1.095 |
| Market capitalization | 1,861 | 1,977 | 2,123 | 2,361 | 2,613 | 2,935 | 3,509 |
| Number of firms | 429 | 469 | 511 | 560 | 624 | 624 | 573 |

(The table is continued on the next page.)

TABLE 6 (Continued)

**Notes:**

In each year from 1979 to 2000, we detect firms for which the difference R&D growth minus earnings momentum ($RDG(5) - EM(5)$) reverses. For example, for 1980, we detect firms that had $RDG(5) - EM(5) > 0$ in 1979 but $< 0$ in 1980. This is our "positive to negative reversal" portfolio. We also detect firms that had $RDG(5) - EM(5) < 0$ in 1979 but $> 0$ in 1980. This is our "negative to positive reversal" portfolio. The remaining firms comprise the "nonreversal" portfolio. We trace these firms five years before and one year after the reversal year. For each of these seven years and for each portfolio, we report mean values of key characteristics including annual raw and abnormal returns. These returns are for the year following the disclosure of the financial statements — that is, we start the annual return calculation from the seventh month after fiscal year -end. The abnormal returns are the residuals from the cross-sectional regression:

$$R_{i,j+1} = c_{0,j} + c_{1,j}\beta_{i,j} + c_{2,j}\ln(M)_{i,j} + c_{3,j}\ln(B/M)_{i,j} + c_{4,j}\ln(A/B)_{i,j} + c_{5,j}[E(+)/M]_{i,j} + c_{6,j}(E/M \text{ dummy})_{i,j} + c_{7,j}\ln(RDC/M)_{i,j} + c_{8,j}R_{i,j} + e_{i,j+1},$$

where $j$ denotes the year relative to the reversal year $t$ — that is, $j = t-5, t-4, t-3, t-2, t-1, t$, and $t+1$. (See variable definitions in the notes to Table 5.) We run this regression each year for all firms and we report the mean of the yearly mean residuals and in parentheses their Fama-MacBeth $t$-statistics for the firms that belong to each portfolio.

Variables are as defined in Table 5.

The pattern and magnitude of abnormal returns in this case are quite similar to those in the corresponding ROE bias reversal portfolio (Table 5, panel A). Both the R&D and earnings growth rates for this portfolio display high variability over the seven-year horizon (fifth and sixth rows). On average, about 143 firms have such positive to negative reversals per year over our sample period. These are not likely to be firms with a similar ROE bias reversal because they are larger in size (market capitalization close to $2.5 billion), have lower systematic risk (beta), have stronger growth (lower $E/P$ and $B/M$ ratios), and are more R&D-intensive (have higher R&D-to-sales ratios) than the *ROE* bias reversal firms. A more direct comparison is described below.

Panel B reports the results for the "negative to positive reversal" portfolio. As in panel A the bias-driving variable, *R&D growth* – *EM*, reverses within a five-year period. It shows a declining pattern, reaching a large negative value in year $t-1$ (−4.243) and reversing to a large positive value in year $t$ (3.315). The prediction for this portfolio is to be overvalued given the presence of aggressive accounting. Evidence of overvaluation and correction are present in both raw and abnormal annual stock returns. Thus, while prior to the reversal year $t$ raw returns are large and positive (38 percent, 22.8 percent, 25.2 percent), they decline in year $t$ (9.6 percent). Abnormal returns are positive prior to the reversal year (13 percent, 2 percent, 4.4 percent), but statistically significant only in $t-4$ (13 percent, $t$-statistic 6.158). However, they become significantly negative in $t-1$ (−6.9 percent, $t$-statistic −6.871) and in the reversal year $t$ (−7.5 percent, $t$-statistic −6.282). Then they converge to 0 percent. This pattern is consistent with a market correction in this case as well. The remaining data in this panel indicate that, on average, about 130 firms have such reversals per year over our sample period. These firms have more stable R&D growth rates than the firms in panel A but have highly variable earnings growth rates. They are somewhat smaller in size but they have similar systematic risk, *E*/*P*, *B*/*P*, and R&D intensity, as the firms in panel A.

Panel C reports the results for the "nonreversal" portfolio of about 624 firms per year. Unlike the other two portfolios, there is no systematic pattern in the stock returns. Raw returns and abnormal returns stay around 20 percent and 0 percent over the seven-year horizon, respectively. Thus, the results in this panel are similar to those in Table 5, panel C. Overall, the results of Table 6 indicate that the earnings momentum bias affects investor behavior.

As we did with the ROE bias portfolio analysis, we summarize the earnings momentum portfolio analysis by plotting the average annual abnormal returns for each of the three portfolios over the seven-year horizon. Figure 2 shows the three lines *AR-NR* for the "nonreversal" portfolio, *AR-PN* for the "positive to negative reversal" portfolio, and *AR-NP* for the "negative to positive reversal" portfolio. All the lines show a pattern consistent with our expectations. Thus, the *AR-NR* line is rather flat and close to zero. The *AR-NP* line shows a clear overvaluation and a subsequent correction pattern: starting positive, declining to negative values, and converging to zero. The *AR-PN* line shows the opposite pattern: an initial undervaluation, then abnormal returns building up to positive values, and converging to zero, consistent with a correction. Overall, these portfolio results indicate that the earnings momentum bias variable has valuation implications and thus provide support for Hypothesis 4.

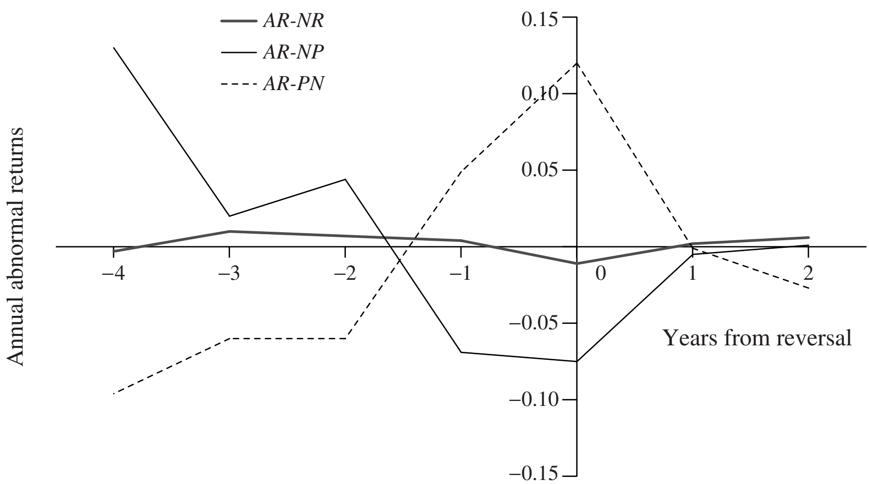
### *Simultaneous ROE and earnings momentum bias reversal*

The above analysis is based on either the ROE or the earnings momentum reversal analysis. It is, however, possible that for some sample firms reversals in *both* ROE and earnings momentum biases occur in the same year. This can be an interesting subsample to examine because firms with such reversals potentially become more visible to investors and thus we expect to detect more pronounced returns patterns than those presented above.

Table 7 reports the results from the simultaneous ROE and earnings momentum bias reversal analysis. Panel A reports the results for the "positive to negative reversal" portfolio. On average, 48 firms have such simultaneous reversals per year over our sample period, which is about 33 percent of firms with either type of reversal reported in panels A of Tables 5 and 6. The bias-driving variable, *R&D growth – ROE*, shows a similar pattern but with larger values than those reported in panel A of Table 5. The same is also true for the bias-driving variable, *R&D growth – EM* (not reported). More importantly, raw and abnormal returns in the bias reversal year $t$ are larger that those reported in panels A of Tables 5 and 6. Thus, raw returns at $t$ are 42.2 percent versus 34.9 percent in panel A of Table 5 and 33 percent in panel A of Table 6. Abnormal returns at $t$ are 17 percent ($t$-statistic 5.201) versus 10.9 percent and 12 percent in panels A of Tables 5 and 6, respectively. Clearly, the market reaction is stronger when both biases reverse from positive to negative.

Panel B reports the results for the "negative to positive reversal" portfolio. On average, 45 firms have such simultaneous ROE and earnings momentum bias reversals per year over our sample period. This is about 29 percent of firms with ROE bias reversals reported in panel B of Table 5 and 35 percent of earnings momentum bias reversals reported in panel B of Table 6. The bias-driving variable, *R&D growth – ROE*, shows a similar pattern, with two reversals, as in panel B of

**Figure 2** Earnings momentum bias reversal analysis




**Notes:**

Annual abnormal returns (*AR*) are plotted for three portfolios formed on the basis of earnings momentum bias reversals. In each year from 1979 to 2000, we detect firms for which the difference R&D growth minus earnings momentum ($RDG(5) - EM(5)$) reverses. For example, for 1980, we detect firms that had $RDG(5) - EM(5) > 0$ in 1979 but $< 0$ in 1980. This is our "positive to negative reversal" (*PN*) portfolio. We also detect firms that had $RDG(5) - EM(5) < 0$ in 1979 but $> 0$ in 1980. This is our "negative to positive reversal" (*NP*) portfolio. The remaining firms comprise the "nonreversal" (*NR*) portfolio. We trace these firms five years before and one year after the reversal year. For each of these seven years and for each portfolio, we calculate annual abnormal returns using the residuals of the following cross-sectional regression:

$$R_{i,j+1} = c_{0,j} + c_{1,j}\beta_{i,j} + c_{2,j}\ln(M)_{i,j} + c_{3,j}\ln(B/M)_{i,j} + c_{4,j}\ln(A/B)_{i,j} + c_{5,j}[E(+)/M]_{i,j} + c_{6,j}(E/M \text{ dummy})_{i,j} + c_{7,j}\ln(RDC/M)_{i,j} + c_{8,j}R_{i,j} + e_{i,j+1},$$

where the variables are as defined in Figure 1.

TABLE 7
Simultaneous ROE and earnings momentum bias reversal analysis

**Panel A:** "Positive to negative reversal" portfolio

| | Years relative to the reversal year $t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | $t-5$ | $t-4$ | $t-3$ | $t-2$ | $t-1$ | $t$ | $t+1$ |
| *R&D growth − ROE* | 0.122 | 0.231 | 0.221 | 0.193 | 0.305 | −0.162 | −0.032 |
| Raw returns | 0.118 | 0.131 | 0.107 | 0.300 | 0.422 | 0.211 | 0.137 |
| Abnormal returns | −0.126 | −0.113 | −0.132 | 0.031 | 0.170 | 0.023 | −0.053 |
| *t*-statistics | (−9.194) | (−6.860) | (−6.996) | (1.301) | (5.201) | (0.996) | (−2.534) |
| R&D growth rate | 0.200 | 0.246 | 0.235 | 0.203 | 0.167 | 0.017 | 0.057 |
| Reported ROE | 0.079 | 0.015 | 0.013 | 0.010 | −0.138 | 0.179 | 0.089 |
| R&D-capitalized ROE | 0.092 | 0.048 | 0.036 | 0.038 | −0.049 | 0.117 | 0.079 |
| R&D-to-sales | 0.067 | 0.194 | 0.086 | 0.101 | 0.133 | 0.054 | 0.148 |
| Earnings-to-price | 0.079 | 0.057 | 0.054 | 0.053 | 0.034 | 0.084 | 0.067 |
| Book-to-market | 0.844 | 0.876 | 0.856 | 0.852 | 0.787 | 0.715 | 0.716 |
| Beta | 1.294 | 1.246 | .241 | 1.205 | 1.153 | 1.129 | 1.155 |
| Market capitalization | 779 | 880 | 912 | 1,006 | 1,312 | 1,414 | 1,699 |
| Number of firms | 44 | 46 | 47 | 48 | 48 | 48 | 44 |

(The table is continued on the next page.)

TABLE 7 (Continued)

**Panel B:** "Negative to positive reversal" portfolio

| | Years relative to the reversal year $t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | $t-5$ | $t-4$ | $t-3$ | $t-2$ | $t-1$ | $t$ | $t+1$ |
| *R&D growth – ROE* | 0.160 | 0.050 | 0.027 | −0.010 | −0.122 | 0.285 | 0.210 |
| Raw returns | 0.327 | 0.270 | 0.313 | 0.160 | 0.100 | 0.173 | 0.244 |
| Abnormal returns | 0.079 | 0.034 | 0.101 | −0.054 | −0.094 | −0.007 | 0.049 |
| *t*-statistics | (2.531) | (1.676) | (3.939) | (−1.973) | (−4.529) | (−0.268) | (1.619) |
| R&D growth rate | 0.173 | 0.112 | 0.098 | 0.072 | 0.041 | 0.218 | 0.210 |
| Reported ROE | 0.013 | 0.062 | 0.071 | 0.082 | 0.163 | −0.067 | 0.000 |
| R&D-capitalized ROE | 0.041 | 0.068 | 0.076 | 0.083 | 0.160 | −0.004 | 0.052 |
| R&D-to-sales | 0.067 | 0.056 | 0.049 | 0.067 | 0.048 | 0.164 | 0.071 |
| Earnings-to-price | 0.060 | 0.076 | 0.075 | 0.073 | 0.087 | 0.035 | 0.048 |
| Book-to-market | 0.920 | 0.829 | 0.764 | 0.730 | 0.727 | 0.762 | 0.755 |
| Beta | 1.217 | 1.217 | 1.189 | 1.179 | 1.144 | 1.147 | 1.123 |
| Market capitalization | 819 | 936 | 1,184 | 1,364 | 1,623 | 1,780 | 1,939 |
| Number of firms | 41 | 43 | 43 | 44 | 45 | 45 | 40 |

(The table is continued on the next page.)

TABLE 7 (Continued)

**Notes:**

In each year from 1979 to 2000, we detect firms for which both differences $\{RDG/[(RDG/2) + 1]\} - ROE$ and $RDG(5) - EM(5)$ reverse. For example, for 1980, we detect firms that had $\{RDG/[(RDG/2) + 1]\} - ROE$ and $RDG(5) - EM(5) > 0$ in 1979 but $< 0$ in 1980. This is our "positive to negative reversal" portfolio. We also detect firms that had $\{RDG/[(RDG/2) + 1]\} - ROE$ and $RDG(5) - EM(5) < 0$ in 1979 but $> 0$ in 1980. This is our "negative to positive reversal" portfolio. The remaining firms comprise the "nonreversal" portfolio. We trace these firms five years before and one year after the reversal year. For each of these seven years and for each portfolio, we report mean values of key characteristics including annual raw and abnormal returns. These returns are for the year following the disclosure of the financial statements — that is, we start the annual return calculation from the seventh month after fiscal year-end. The abnormal returns are the residuals from the cross-sectional regression:

$$R_{i,j+1} = c_{0,j} + c_{1,j}\beta_{i,j} + c_{2,j}\ln(M)_{i,j} + c_{3,j}\ln(B/M)_{i,j} + c_{4,j}\ln(A/B)_{i,j} + c_{5,j}[E(+)/M]_{i,j} + c_{6,j}(E/M \text{ dummy})_{i,j} + c_{7,j}\ln(RDC/M)_{i,j} + c_{8,j}R_{i,j} + e_{i,j+1},$$

where $j$ denotes the year relative to the reversal year $t$ — that is, $j = t-5, t-4, t-3, t-2, t-1, t$, and $t+1$. (See variable definitions in the notes to Table 5.) We run this regression each year for all firms and we report the mean of the yearly mean residuals and in parentheses their Fama-MacBeth $t$-statistics for the firms that belong to each portfolio.

Variables are as defined in Table 5.

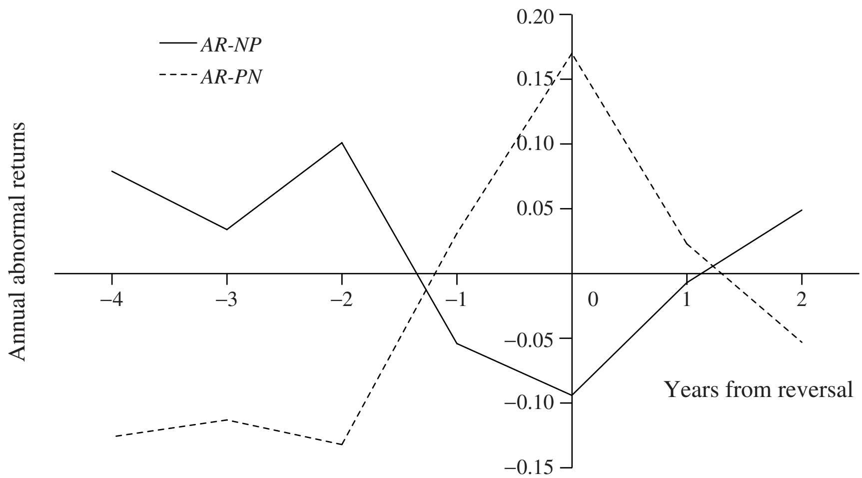
Table 5. The returns patterns are also similar with abnormal returns at $t - 2$ significantly positive (10.1 percent, $t$-statistic 3.939), and at $t$ not only significantly negative (−9.4 percent, $t$-statistic −4.529) but also of larger magnitude (−7.6 percent in panel B of Table 5). Again, the market reaction appears to be stronger when both biases reverse.

In Figure 3 we plot the average annual abnormal returns for each of the two portfolios over the seven-year horizon. The line for the "positive to negative reversal" portfolio, *AR-PN*, starts and stays negative for three consecutive years, indicating strong undervaluation, then it become positive (reverses), and converges to 0 percent, consistent with correction. The line for the "negative to positive reversal" portfolio, *AR-NP*, displays the opposite pattern: starts and stays positive for three consecutive years, indicating overvaluation, then becomes negative (reverses), and converges to 0 percent by $t + 1$. The opposite movement in the two lines is clear and consistent with undervaluation in one case and overvaluation in the other. The evidence from these two portfolios provides strong support for our Hypotheses 3 and 4.

### *Sensitivity analysis*

We carried out additional analyses to examine the sensitivity of the results reported above. First, we used a three-year earnings growth rate calculation rather than five, with essentially identical results. In addition, because growth rates, the way we calculated them above, can be noisy (excessive weight is placed on the first and last observations), we also used the method employed by Dechow and Sloan 1997 that smoothes the calculation.[24] Only marginal improvements appeared in some results. Second, we examined whether large mergers and acquisitions have an impact on our results by identifying sample firms with at least 50 percent change in annual sales. We detected 2,098 such large mergers over our sample period. Of those, 236 are for firms that belong to our "positive to negative reversal" portfolio — that is, about 9 firms per year on average — and 189 are for firms that belong to our "negative to positive reversal" portfolio — that is, about 7 firms per year on

**Figure 3** Simultaneous ROE and earnings momentum bias reversal analysis




**Notes:**

Annual abnormal returns (*AR*) are plotted for two portfolios formed on the basis of both ROE bias and earnings momentum bias reversals. In each year from 1979 to 2000, we detect firms for which both differences $\{RDG/[(RDG/2)+1]\} - ROE$ and $RDG(5) - EM(5)$ reverse. For example, for 1980, we detect firms that had $\{RDG/[(RDG/2)+1]\} - ROE$ and $RDG(5) - EM(5) > 0$ in 1979 but $< 0$ in 1980. This is our "positive to negative reversal" (*PN*) portfolio. We also detect firms that had $\{RDG/[(RDG/2)+1]\} - ROE$ and $RDG(5) - EM(5) < 0$ in 1979 but $> 0$ in 1980. This is our "negative to positive reversal" (*NP*) portfolio. We trace these firms five years before and one year after the reversal year. For each of these seven years and for each portfolio, we calculate annual abnormal returns using the residuals of the following cross-sectional regression:

$$R_{i,j+1} = c_{0,j} + c_{1,j}\beta_{i,j} + c_{2,j}\ln(M)_{i,j} + c_{3,j}\ln(B/M)_{i,j} + c_{4,j}\ln(A/B)_{i,j} + c_{5,j}[E(+)/M]_{i,j} + c_{6,j}(E/M \text{ dummy})_{i,j} + c_{7,j}\ln(RDC/M)_{i,j} + c_{8,j}R_{i,j} + e_{i,j+1},$$

where the variables are as defined in Figure 1.

average. We did not detect any large mergers in our "simultaneous ROE and earnings momentum reversal" portfolio. We rerun the portfolio analyses excluding the firms with large mergers, and observed minor changes in the results, but our inferences did not change.

## 6. Summary and conclusions

In this study we ask the questions when is the immediate expensing of R&D (current GAAP) conservative and when is it aggressive, relative to reporting under R&D capitalization, and what are the capital-market implications of these reporting biases. To address these questions, we construct a model of profitability reporting biases and identify the key drivers of the reporting biases: the differences between R&D growth rate and earnings (change) momentum, and between R&D growth and ROE. In general, companies with a high growth rate of R&D relative to their profitability (typically, early life-cycle companies) report conservatively, while firms with a low R&D growth rate relative to profitability (mature companies) tend to report aggressively.

In our initial empirical analyses, we validate the predictions of the model on a large sample of firms. Thus, profitability reporting biases are present in the data, and they appear to be significant for both ROE and earnings momentum. We then analyze the stock returns of the sample firms to examine whether investor valuations are affected by the profitability reporting biases. We find evidence consistent with investor fixation on the reported profitability measures. Thus, the stocks of conservatively reporting firms appear to be undervalued, while the stocks of aggressively reporting firms appear to be overvalued, and these misvaluations appear to be corrected when the reporting bias reverses from conservative to aggressive, or vice versa. In addition, the misvaluations are significant for both ROE and earnings momentum profitability indicators. The misvaluation evidence we detect is consistent with well-established behavioral finance findings and, in particular, with the heuristic of representativeness that makes investors view patterns in reported data as representative about future patterns and thus overreact.

The social relevance of systematic mispricing of securities is that it leads to misallocation of resources in both the real and capital markets. Systematic undervaluation of stocks, for example, implies that the underpriced firms are burdened with excessive cost of capital, leading to suboptimal investment and stunted growth. In the capital markets, mispricing of securities causes wealth transfers between current and new shareholders. Alleviating mispricing is obviously beneficial to firms, shareholders, and society at large. In closing, we should note, however, that there is no assurance that a GAAP requirement for the capitalization of R&D will eliminate all the current mispricings, although the preliminary evidence (e.g., Aboody and Lev 1998) is encouraging.

## Appendix

If the growth rate of R&D expense is zero, then after a full amortization cycle is complete, both capitalizing and expensing firms will have the same earnings, but the capitalizing firm will have more assets and thus lower ROA (or ROE). To see this, set $g = 0$ and notice that both firms have the same income in years $t \geq T$ but the assets/equity of the capitalizing firm is higher in all periods after $T$:

$$BVA_n^c = BVA_n + \sum_{i=1}^{T-1} \left[\frac{iC}{T}\right] = BVA_n + \left[\frac{T(T-1)}{2}\right]C.$$

Thus, the capitalizing firm has a lower return on assets in any year $t < T$. The argument for return on equity is similar after adjusting for the tax rate.

The extension of this result to the case where the growth rate is nonzero involves the observation that as long as the depreciation pattern used by the firm is stable, the unrecorded R&D asset also grows at the rate $g$.[25] That is, denoting the (unrecorded) R&D asset at time $n$ by $RD\_CAPn$, the asset in year $n + 1$ will be $(1 + g)RD\_CAPn$. The consequences for ROE may now be derived. First, by definition, $BVA_n^c = BVA_n + RD\_CAP_n$. Second, we have the following relationship between earnings in year $n$ measured under the two different accounting methods:

$$E_n^c = E_n + (1-\tau)(RD\_CAP_n - RD\_CAP_{n-1}) = E_n + (1-\tau)gRD\_CAP_{n-1}.$$

Combining these results, we obtain a result that links the growth rate of expenditures and the decision to capitalize or expense these expenditures with the reported return on assets and equity. Before deriving this result, we state a simple but useful fact as a separate lemma mainly for ease of reference.

***Lemma 1***

Suppose $y + z > 0$ and $z > 0$. Then for any $x$, $y$, $\frac{(x+w)}{(y+z)} \geq \frac{x}{y} \Leftrightarrow \frac{x}{y} \geq \frac{w}{z}$.

***Proof of Lemma 1***

Cross-multiplying and using the fact that $y + z$ and $z$ are positive, we obtain:

$$\frac{(x+w)}{(y+z)} \geq \frac{x}{y} \Leftrightarrow x + w \geq x + \frac{xz}{y} \Leftrightarrow w \geq \frac{xz}{y} \Leftrightarrow \frac{w}{z} \geq \frac{x}{y}. \qquad \blacksquare$$

***Proof of Proposition 1***

Let

$$x = E_n$$

$$w = (1-\tau)gRD\_CAP_{n-1}$$

$$y = \frac{BVA_n + BVA_{n-1}}{2}$$

$$z = \frac{BVA_n^c + BVA_{n-1}^c}{2} - \frac{BVA_n + BVA_{n-1}}{2} = \frac{RD\_CAP_n + RD\_CAP_{n-1}}{2}$$

$$= RD\_CAP_{n-1}\left(1 + \frac{g}{2}\right).$$

Substituting for $E_n^c$ and $BVA_t^c$ from the identities derived earlier, Lemma 1 shows that

$$ROA_n = \frac{E_n}{\tfrac{1}{2}(BVA_n + BVA_{n-1})} \geq \frac{E_n^c}{\tfrac{1}{2}(BVA_n^c + BVA_{n-1}^c)}$$

$$= \frac{E_n + w}{\tfrac{1}{2}(BVA_n + BVA_{n-1}) + z} \Leftrightarrow \frac{E_n}{\tfrac{1}{2}(BVA_n + BVA_{n-1})} \geq \frac{w}{z}$$

$$\Leftrightarrow \frac{E_n}{\tfrac{1}{2}(BVA_n + BVA_{n-1})} \geq \frac{(1-\tau)g}{1 + (\tfrac{1}{2})g}$$

Note that in the expressions above, $y, z$, and $y + z$ are all positive, as required in Lemma 1. This establishes the result of the proposition for ROA. The analogous criterion for ROE is $ROE_n \geq g/(1 + g/2)$. To see this, note that the difference in the book value of equity is $(1 - \tau)z$ (where $z$ is as defined above). Thus, the analogous ratio is $w/(1 - \tau)z$, yielding the required result. ■

Proposition 1 compares return on assets and return on equity across policies of expensing and capitalizing expenditures. The intuition underlying the finding is straightforward: under positive expenditure growth, earnings under expensing, $E_n$, are always less than earnings under capitalization, $E_n^c$; however, total assets (or equity) also increase under capitalization. The question then becomes whether the numerator increase outweighs the denominator increase. The criterion stated in the proposition provides a simple relationship between the growth rate of earnings and the growth rate of expenditures that characterizes when a policy of expensing R&D might lead to higher reported ratios. At a growth rate of zero, there is no effect on the numerator, and it is always better to expense. As the growth rate becomes increasingly positive, the gain in reported income outweighs the increase in assets/equity resulting in a higher ROA/ROE under capitalization. This intuition is straightforward; the interest in the proposition stems from the simplicity of the cut-off point where capitalization increases ROA and, in particular, that this cutoff does not depend on the length of the amortization cycle.

***Proof of Proposition 2***

Let $E_n$ represent the earnings of the firm that expenses R&D, and $EM_n = (E_n - E_{n-1})/E_{n-1}$ represent the earnings growth of this firm. Then the earnings of the capitalizing firm, $E_n^c$, is given by $E_n^c = E_n + (1 + g)X$, $E_{n-1}^c = E_{n-1} + X$, where $X = \Delta RD\_CAP_{n-1}$.

Therefore, the earnings growth of the firm that capitalizes R&D, denoted $EM_n^c$, is given by

$$EM_n^c = \frac{E_n^c - E_{n-1}^c}{E_n^c} = \frac{(E_n - E_{n-1}) + [X(1+g) - X]}{E_{n-1} + X} = \frac{(E_n - E_{n-1}) + Xg}{E_{n-1} + X}$$

Using the lemma stated earlier, with $x = (E_n - E_{n-1})$, $y = Xg$, $w = E_{n-1}$, and $z = X$, we obtain $EM_n \geq EM_n^c \Leftrightarrow EM_n \geq g$ (notice that we need $E_n^c > 0$ to apply the lemma). ■

Intuitively, if the growth rate in R&D expenditures is positive, earnings are always higher under capitalization. The same intuition shows that for any positive growth rate in R&D expenditures, the earnings change, $E_n - E_{n-1}$, is greater under capitalization. The result in Proposition 2 shows that under high earnings growth and low expense growth, the reduction in the denominator, $E_{n-1}$, under expensing is proportionately greater than the reduction on the earnings change, $E_n - E_{n-1}$, found in the numerator. For firms with these growth characteristics, earnings growth is overstated under a policy of expensing R&D expenditures.

## Endnotes

1. The only exception to the expensing of intangibles in the United States is the capitalization of some software development costs, as required by *Statement of Financial Accounting Standards* (*SFAS*) *No. 86* (Financial Accounting Standards Board [FASB] 1985). For an empirical examination of software capitalizations, see Aboody and Lev 1998. For a discussion of the evidence concerning R&D benefits, see Lev 1999.
2. “Thus if the animal spirits are dimmed and the spontaneous optimism falters, leaving us to depend on nothing but a mathematical expectation, enterprise will fade and die” (Keynes 1936, 161–2).
3. Kothari, Laguerre, and Leone (2002) report that the earnings volatility associated with R&D is three times larger than that associated with tangible investment in property, plant, and equipment.
4. By aggressive reporting, we do not mean that the companies “manage” or manipulate their reported earnings. Rather, following the full expensing of R&D mandated by GAAP results in an overstatement of the change in earnings, relative to the capitalization of R&D.
5. Our evidence complements the evidence reported by Luft and Shields 2001, who use an experimental setting in which the subjects are master of business administration students. Evidence from the experiment indicates that when individuals use information on intangible expenditures to predict profits, expensing the expenditures (versus capitalizing) significantly reduces the accuracy, consistency, consensus, and self-insight of individuals’ subjective profit predictions. The authors point out that,

consistent with psychological theories of learning, individuals do not learn the exact magnitude of the effect of intangibles on future profits as well when the intangibles are expensed. The study implies that decisions based on the expensing of intangibles may lead to mistakes. We confirm with actual data that indeed investors appear to make mistakes, given the expensing of R&D.

6. Beaver and Ryan (2005) develop a theoretical model that allows for independent levels of accounting bias in tangible and intangible assets. However, their notion of conservatism is based on the relationship between book and market values, whereas our definition involves a comparison of book values under alternative accounting treatments. Although there are some general connections between the papers, the specific point of the analysis in Beaver and Ryan concerns the interaction between the expensing of intangibles and the write-down of tangible assets, rather than a direct relationship between the treatment of intangibles and the consequences for market prices. Specifically, Beaver and Ryan observe that the immediate expensing of intangibles and an uncertain impairment yield noise in the relation between share returns and write-downs of tangible assets.
7. Results are available from the authors on request.
8. A real-life example of such aggressive reporting of ROE is provided by Lev and Sougiannis 1996 (appendix) for Merck & Co. In 1991, Merck's annual R&D growth rate was 15.7 percent, substantially lower than reported ROE (0.55). Our model (above) suggests that in this case (where $ROE > g/(1 + g/2)$), the return on equity under capitalization of R&D will be *lower* than ROE under expensing. This, indeed, is the case for Merck: ROE under capitalization was 0.40 in 1991, compared with a reported ROE of 0.55. Further, Merck's reported three-year earnings change in 1991 (relative to 1988) was 76 percent. This growth rate is higher than the 1991 (three-year) R&D growth rate (47.7 percent), and our model predicts that in this case the reported momentum will be higher (aggressive reporting) than the earnings momentum under R&D capitalization. This, indeed, is the case. The 1991 (three-year) momentum under R&D capitalization is 70 percent, while the reported momentum is 76 percent.
9. There is significant psychological evidence indicating that people form their predictions about the future without fully accounting for mean reversion (e.g., Kahneman and Tversky 1982).
10. Indeed, Aboody and Lev (2000) report that insider gains in R&D-intensive companies are substantially higher than in firms with no (or low) R&D.
11. Uniform rates are frequently used in economic research (for example, the 15 percent rate assumed in Hall, Cummings, Laderman, and Mundy 1988).
12. We also used a three-year growth rate calculation. The empirical results are almost identical to those reported below.
13. A report by the Council on Competitiveness (Porter and Stern 1999) strongly warns about dangers to U.S. competitiveness from decreases in the growth rate of R&D, particularly basic research.
14. What we are actually testing here is that the aggregation into portfolios preserves the relationship described in Propositions 1 and 2.
15. We thank an anonymous reviewer for this suggestion.

16. Results based on the first variation are very similar to those reported in Table 3 and are available on request. In our analyses, we controlled for outliers by eliminating firms with negative book values and extremely large market-to-book ratios or earnings momentum.
17. On the basis of a reviewer's comment, we also allowed for the possibility of a disproportionate R&D growth in the early years of the five-year period over which R&D growth is measured. Thus, if in the first two years R&D growth is very high relative to the last three years, the current *ROE* may not reflect the expected amount of bias. To alleviate this concern we used a five-year *ROE* calculated as:

$$ROE(5) = \frac{\Sigma_{\tau=0}^{4}[E_{t-\tau} + (R^{\tau} - 1)D_{t-\tau}]}{(BVE_{t-5} + BVE_t)/2},$$

where *E* is reported earnings (COMPUSTAT item no. 172), *D* is common dividends (COMPUSTAT item no. 21), *BVE* is book value of equity (COMPUSTAT item no. 60), and *R* is 1 plus the average discount rate of 12 percent. The numerator is cum-dividend aggregate earnings over the five-year horizon — that is, it also includes earnings from the reinvestment of dividends and thus is consistent with Ohlson 1995. We formed portfolios by ranking firms on five-year R&D growth minus five-year ROE, $[RDG(5) - ROE(5)]$, and R&D-to-sales. The results, available on request, are very similar to those reported in Table 3.
18. We also run the momentum analysis using the first variation of the portfolio approach — that is, initially classifying firms into three $EM(5)$ portfolios and then, within each $EM(5)$ portfolio, classifying firms into three R&D growth portfolios. The results of this analysis, available on request, are stronger than those reported in Table 4 — that is, differences between reported and R&D-capitalized earnings changes in all nine portfolios are in the expected direction. All median and three mean differences are significantly different from zero.
19. Despite the nonlinearities in the theoretical relationships between the key variables (R&D growth and profitability measures), we also carried out a regression analysis of reporting biases. Specifically, we regressed for the pooled sample (with time and industry dummy variables) the reporting bias — namely, the difference between the firm's reported and R&D-capitalized earnings momentum (that is, $EM(5) - EM(5)^C$) — on the theoretical driver of the bias the difference between R&D growth and reported earnings momentum (that is, $RDG(5) - EM(5)$). Additional independent variables are the squared difference between $RDG(5)$ and $EM(5)$ (to capture some nonlinearities), log firm size, and R&D intensity ($RDS$). A similar regression was run for *R&D growth* and *ROE* — namely, $ROE - ROE^C$ (the *ROE* reporting bias) — regressed on the following variables: $\{RDG/[(RDG/2) + 1]\} - ROE$, $(\{RDG/[(RDG/2) + 1]\} - ROE)^2$, log firm size, R&D intensity, and time and industry dummy variables. The estimated coefficients of the "drivers of reporting biases" — namely, $RDG(5) - EM(5)$ and $\{RDG/[(RDG/2) + 1]\} - ROE$ — are negative and highly significant, (−0.852, $t = -42.74$) and (−0.441, $t = -68.95$), respectively. These coefficients indicate that when the R&D growth rate is larger than the earnings momentum, reported momentum tends to become smaller than R&D-capitalized momentum (conservatism bias), and vice versa for R&D growth below the earnings momentum (an aggressive bias). Similarly, as predicted by the model, for

R&D growth above ROE, reported ROE will fall short of R&D-capitalized ROE (conservative bias).

20. We also estimated (3) after adding the reporting bias in ROE or earnings momentum as independent variables and examined the sign and significance of their coefficients. We used the variables $\{RDG/[(RDG/2) + 1]\} - ROE$ and $RDG(5) - EM(5)$ directly in the regression, and we also constructed bias score variables as suggested by Fama and MacBeth 1973. We estimated monthly returns regressions as in Fama and French 1992 up to a seven-year-ahead horizon. The results show a positive coefficient for the bias reversal from positive to negative, consistent with correction of undervaluation of these firms at $t$, and a negative coefficient for the bias reversal from negative to positive, consistent with correction of overvaluation of those firms at $t$. However, although coefficient signs are consistent with mispricing corrections, the reporting bias variable coefficients are not significant. The results and details of this analysis are available on request.
21. The significantly negative abnormal return in $t + 1$ indicates a slow market reaction that can be the result of short-selling constraints and transaction costs that delay market correction (the limited arbitrage argument in behavioral finance — e.g., Shleifer 2000).
22. The patterns observed in the average values reported in panels A and B are also present in yearly values. The persistence of aggressive accounting over a shorter period than conservative accounting can be due to competitive forces that eliminate excess profitability in short horizons.
23. The abnormal returns for $t - 4$, $t - 3$, and $t - 2$ are small but still statistically significant. However, there is no systematic pattern in these abnormal returns.
24. Under this method we fit a least squares growth line to the logarithms of the five annual earnings or R&D observations.
25. By a stable pattern of depreciation, we mean that for an asset of value $A$ bought in year $t$, the depreciation in year $t + n$, denoted by $\delta_{t,n}A$, depends only on the value of n and is independent of the year of purchase, $t$ — that is, $\delta_{t,n}A = \delta_{s,n}A$ for every $s$, $t$.We are thankful to an anonymous referee for bringing this approach to our attention. Under an assumption of straightline depreciation, a closed-form expression can be derived for this unrecorded asset, as we showed in an earlier version of this paper.

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