Capitalizing research & development and 'other information': the incremental information content of accruals versus cash flows

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Abstract This paper studies the role of the accrual process for providing value relevant information on intangibles. Expensing research & development (R&D) expenditures is, by nature, equivalent to cash accounting. Prior studies have found that accrual information has superior explanatory power for market values compared to cash flows (Dechow in J. Account. Econ. 18(1):3–42, 1994). We demonstrate, for a sample of German firms, that this also holds true for R&D accounting. By adjusting the earnings we create two samples reflecting R&D capitalization and expensing, respectively. We demonstrate that capitalizing R&D expenditures creates an additional accrual component of earnings which increases the explanatory power of earnings compared to cash flows (expensing) while internalizing 'other information' into the accounting system. This explains the higher value relevance of capitalized R&D compared to expensing established in prior research (Lev and Sougiannis in J. Account. Econ. 21(1):107–138, 1996).

Keywords Accruals · Other information · Research and development · Value relevance

1 Introduction

Prior empirical research has established that the capitalization of research and development (R&D) expenditures is value relevant (Lev and Sougiannis 1996;

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Aboody and Lev 1998). Capitalizing R&D increases the explanatory power of earnings for market values. In this paper, we analyze the source of this additional explanatory power. This is controversial because market values capture all publicly available information and it is not clear why accounting as a source of information would be beneficial over other sources of information, like the management report or informal channels of communication. To answer this question, we make use of the general benefits of accrual accounting documented in prior research (e.g. Dechow 1994). Research on the benefits of accrual accounting compared to cash accounting (Barth 2000) has found that timing and matching problems are a major dilemma of cash flows. This results in a better ability of accrual information to explain market values and returns (Wilson 1986; Dechow 1994). Given their high uncertainty, it is unclear whether this general finding for the accrual process translates to R&D expenditures.

The objective of this paper is to explain the source of the additional explanatory power of earnings when R&D is capitalized compared to an expensing regime. Value relevance studies assume market values reflect all publicly available information, independent of their source. Especially in studies using adjusted accounting data (e.g. Lev and Sougiannis 1996), the market has not received the information included in market values via accounting but from other sources. If R&D capitalization results in higher explanatory power, we assume that this 'other information' is substituted into the accounting figures when R&D is capitalized, making the accounting system richer. However, when considering both sources of information, having the same information in either source would not, by itself, warrant higher explanatory power. Only if including the information in the accounting system is accompanied with benefits, we can expect the combined information set to display higher explanatory power. When considering the benefits of accrual accounting documented in prior research, we expect that including the R&D information in accrual accounting results in similar benefits as documented for accrual accounting in general. Hence, our research questions are: (1) *Does the (adjusted) capitalization of R&D lead to higher value relevance compared to expensing due to the benefits of accrual accounting?* and (2) *Can this higher value relevance be attributed to 'other information' being integrated into the accounting system?*

The accrual concept is one of the hallmarks of accounting. Fundamentally, there are two different accounting concepts: cash accounting and accrual accounting. Cash accounting is often regarded the more 'primitive concept' (Bowen et al. 1987). Standard setters make explicit use of accrual accounting. In accrual accounting, expenditures linked with future benefits are treated as assets, that is, are capitalized. Various studies provide evidence that in fact R&D expenditures are, on average, highly and strongly associated with future benefits (Lev and Sougiannis 1996, 1999; Hand 2003). This can be taken as evidence that R&D can be considered an asset. In this paper, we provide a comprehensive overview of the empirical evidence in regard to capitalizing intangibles which largely confirms that R&D capitalization yields value relevant information. In fact, standard setters such as the IASB have based their decisions to prescribe or allow R&D capitalization on this evidence (IAS 38 BCZ 39 c). In their latest reform of the Commercial Code (Handelsgesetzbuch, HGB) in 2009, the German government has also decided to allow for selective R&D capitalization as an option.[1] There is no extant evidence, however, as to what drives the additional value relevance demonstrated in prior research. We provide evidence that it is in fact the accrual process that explains it. Accruals are better measures of performance and, as such, better reflect expectations on future cash flows than do realized cash flows (Dechow 1994).

To address our research questions, we apply an approach adapted from Dechow (1994) in order to investigate the accrual information resulting from R&D capitalization. We analyze a sample of the 150 largest German listed firms for the period 2001–2006. Germany is an interesting object of study in this context, as R&D plays a significant role in the economy. Traditionally lacking large natural resources, Germany has built much of its economic success on R&D. Our sample comprises firms with significant R&D activities listed on the German stock market. We adjust their actual R&D accounting to create two samples reflecting either R&D capitalization (capitalizing sample) or expensing (expensing sample). We compare the explanatory power of the resulting book values and earnings between the two samples. We expect R&D capitalization (i.e. accrual accounting) to provide superior information compared to expensing (i.e. cash accounting). Following Dechow (1994) we decompose earnings into its cash flow and accrual components. We expect that decomposed earnings provide incremental information. This allows us to isolate the accrual component of earnings created by capitalizing R&D. We expect the R&D accrual to significantly add to the explanatory power of the regression. We provide evidence consistent with these arguments.

We extend the original Dechow (1994)-model by including book values, consistent with Collins et al. (1999), to avoid biases from correlated omitted variables in the simple earnings capitalization model. We also enhance the model by ‘other information’, in accordance with Ohlson (1995) as suggested by Barth et al. (2005). ‘Other information’ refers to publicly available information not included in accounting variables. We step by step disaggregate earnings into its cash flow- and accrual-components. We integrate long-term accruals into our analysis, which are less pronounced in prior research on the benefits of accrual accounting, but are relevant when studying R&D investments.

We find that capitalizing R&D increases the explanatory power of book values and earnings even when simultaneously considering ‘other information’. We also find that decomposing earnings into cash flows and accruals increases explanatory power. The R&D accrual created when capitalizing R&D significantly adds to the explanatory power of the regression. In turn, the level and weight of ‘other information’ decreases when capitalizing R&D. This indicates that by capitalizing R&D, ‘other information’ is integrated into the accounting system. At the same time, the explanatory power of the full data set, including both ‘other information’ and the R&D accruals, increases. This indicates that internalizing the information in accrual accounting is more useful in explaining market values than leaving the information in ‘other information’. Based on the findings of the accrual literature, this is due to the

[1] Under §248 HGB development costs may be capitalized when an asset is likely to be generated. The rule is very similar to IAS 38, but is an explicit option.

benefits of accruals over cash flows, that is, the better predictive power of accruals over cash flows.

We contribute to the literature on intangibles by providing evidence that capitalizing R&D creates a value relevant accrual component of earnings which significantly adds to the explanatory power of earnings and explains the additional explanatory power of R&D capitalization demonstrated in many studies. We provide a comprehensive literature review regarding both issues. Our approach allows us to confirm the benefits of accrual accounting in general and applied to R&D expenditures in particular. The value relevance approach assumes that prices reflect all available information on R&D projects. R&D capitalization thus does not tell the market new information which it would not already have from other sources. Our results thus do not allow us to infer that R&D capitalization is a better form of accounting, but only that market values, as an aggregate measure for publicly available information from various sources, are more consistent with capitalization than expensing. In particular, we do not analyze the actual R&D accounting of our sample firms, but artificially created figures. Actual R&D capitalization is accompanied by discretion and therefore involves additional attributes. Discretionary R&D capitalization can be informative due to its signaling value (e.g. Ahmed and Falk 2006) or involve earnings management (Markarian et al. 2008). In this study, we focus on earnings and book values based on capitalization or expensing, created without managerial discretion. This allows us to tease out the accrual aspects of R&D capitalization rather than analyzing the signaling or earnings management consequences.

The remainder of the paper is organized as follows. Section 2 summarizes prior research of the two literature branches mentioned above and develops our hypotheses based on the linkage of intangibles and accruals according to the framework. Section 3 shows our research design. Section 4 describes the sample selection and data, and Sect. 5 presents the results. Section 6 summarizes and concludes the study.

2 Prior research and hypothesis development

In this paper we combine two branches of the accounting literature in order to provide an answer to the ongoing debate about the advantages of capitalizing intangibles. The first branch which we address deals with the value relevance of intangibles. The results of these studies establish that intangibles such as R&D, advertising, and personnel development are value relevant. Various studies provide evidence that the capitalization of R&D, as an example of innovation capital, provides value relevant information (Aboody and Lev 1998; Hand 2003; Lev and Sougiannis 1996). In this paper, we analyze the role of the capitalization process in providing additional information via the accrual process. For this purpose, we make use of a second branch of literature showing that accrual information has superior predictive ability compared to cash flows (Dechow 1994; Wilson 1986). From this, we hypothesize that it is the accrual process that leads to a superior market value explanatory power of R&D capitalization.

2.1 Capital market relevance of R&D accounting

Numerous empirical studies examine the relevance of the accounting for intangibles for the capital market. Questions addressed include issues such as whether announcements on expenditures on intangibles influence investors' decisions (decision relevance), or whether the reporting on intangibles in different manners influences the quality of analysts' forecasts (forecast relevance), or whether accounting information is able to explain a company's market value (value relevance). A comprehensive analysis on previous papers suggests a classification of the R&D literature consistent with the different approaches of capital market research (event studies, association studies (analysts' forecasts), and association studies (value relevance)) similar to Möller and Hüfner (2002).[2] The appendix uses this classification for a classification of the literature on intangibles. As the overview shows, the majority of studies are value relevance studies which are therefore in the focus of our study as well. A comprehensive literature review is found in Wyatt (2008). In the following, we focus on the literature relevant to our study.

Event studies on announcements of increased R&D expenditures find overall statistically significant positive abnormal returns (e.g. Wooldridge 1988; Woolridge and Snow 1990; Chan et al. 1990; Zantout and Tsetsekos 1994; Szewczyk et al. 1996).

Forecast relevance studies in the field of intangibles focus on aspects concerning the impact of accounting treatment of intangibles on forecasts as can be observed in earnings variability and forecast errors. In contrast to value relevance studies, forecast relevance studies do not regress on market value but on variables such as analysts' forecast errors, earnings change, the number of analysts following a firm in one year or the number of analysts covering a firm. Overall the findings show a positive relationship between total underlying intangibles and higher analyst following (Barron et al. 2002), a positive association between intangibles and analyst coverage (Barth et al. 2001c), and a positive association between forecast errors and intangible intensity (Gu and Wang 2005). In an Australian GAAP environment Matolcsy and Wyatt (2006) provide evidence for the positive signaling effect of capitalization of intangibles in terms of higher analyst following and lower absolute earnings forecast errors for firms with a stock of underlying intangibles.

The appendix demonstrates that most studies on intangibles are value relevance studies and are designed as association studies based on stock price or stock return. Information is termed value relevant if it has explanatory power for the market value of equity. These studies deal with the trade-off between relevance and reliability related to expenditures on intangibles. In general, value relevance studies try to operationalize these two qualitative criteria of accounting, which determine decision useful information (Barth et al. 2001a). A large number of studies analyze the question as to whether intangibles like R&D can be considered an asset and treated as such. Lev and Zarowin (1999) find a linkage between intangibles, business change, and the loss of value relevance of financial information. They provide evidence for a declining

[2] Similarly, Lo and Lys (2000) distinguish studies on information content from valuation relevance and value relevance.

explanatory power of accounting information due to the increasing importance of intangibles over time. As a remedy, they propose the capitalization of intangibles or the restatement of financial reports. As an Australian answer to Lev and Zarowin (1999), Goodwin and Ahmed (2006) find an increase in value relevance of earnings and book value for capitalizers but no significant improvement for non-capitalizers. The overall findings of value relevance studies show that, by focusing on relevant information, expensing R&D does not provide value relevant information. However, by capitalizing and amortizing such assets, an increase in value relevance can be confirmed.

Existing studies often use adjusted data, as the legal environment under consideration does not allow for actual capitalization. Since SFAS 2 does not permit R&D capitalization, value relevance studies using US data had to adjust earnings and book value to create 'as-if' R&D capitalization. Based on the restated financial information, empirical results suggest that by capitalizing R&D, the value relevance of accounting figures increases (e.g. Lev and Sougiannis 1996; Sougiannis 1994). Other US studies analyze the capitalization of software development expenditures under SFAS 86 and also demonstrate higher value relevance of financial information and decreasing information asymmetry in such a setting (e.g. Aboody and Lev 1998; Mohd 2005). Yet, despite the increasing value relevance of financial information, empirical findings also show that from a forecast perspective, analysts' forecast errors increase when software development expenditures are capitalized due to higher earnings volatility induced by the risk and uncertainty of future economic benefits (e.g. Aboody and Lev 1998; Shi 2002).

There are other studies using actual R&D data in countries where the corresponding GAAP allow such an accounting (e.g. Australia, Canada, France, Italy, UK). These different settings provide for different findings which make it difficult to conclude whether capitalization of R&D really provides more value relevant financial information than expensing. Also, using actual capitalizers in the sample makes it necessary to control for endogeneity effects because the decision to capitalize R&D or not may simultaneously depend on the underlying economics of the firm (e.g. Oswald 2008; Wyatt 2005).

Especially Australia, but also France provide an interesting object for research, as, before the adoption of IFRS, the capitalization of R&D was allowed and subject to the management's discretion. In such an environment, the impact of capitalization can directly be observed. As a result, Australian studies show that capitalizers present higher value relevance of earnings, whereas the expensing of intangibles decreases the usefulness of accounting information (Ahmed and Falk 2006; Barth and Clinch 1998; Ritter and Wells 2006). In such studies of observable capitalization, the signaling aspect has played a central role as a conveyor of information. For Australia, actual R&D capitalization has been shown to improve the value relevance of financial information (e.g. Abrahams and Sidhu 1998; Ahmed and Falk 2006; Smith et al. 2001).

However, in other countries outside Australia, empirical studies have found that discretionary R&D capitalization is used as a tool of earnings management and is therefore harmful to the usefulness of financial information (e.g. Cazavan-Jeny and

Jeanjean 2006 for France; Markarian et al. 2008 for Italy).[3] Discretion can thus play a negative role for the informativeness of capitalization. R&D and similar intangibles being inherently uncertain, a strong argument against the capitalization of intangibles is held both by standard setters and the literature with regard to a presumed lack of reliability of capitalization (for a theoretical reflection see Barth et al. 2003; Herrmann et al. 2006). For intangibles, future cash flows are considered to be too uncertain to qualify as an asset.[4]

Given the difficulties of measuring reliability empirically, only few studies have attempted to analyze this side of value relevance. The appendix notes in brackets which of the value relevance studies do so. For example, Kothari et al. (2002) provide evidence on higher earnings volatility of R&D-expenditures compared to property, plant, and equipment (PPE) and conclude that R&D may not qualify as an asset due to the higher uncertainty of future benefits. Based on their results, Amir et al. (2007) find increased earnings volatility in industries with high R&D-intensity as compared to physical capital intensity only. Their results support R&D capitalization under certain circumstances, as in industries with rather low R&D-intensity, such expenditures cannot be considered more risky or less reliable. In addition, they show that R&D investments are, on average, recoverable in all industries, indicating that future economic benefits can be attributed to intangible expenditures in the majority of cases. Higher earnings variability due to investments in intangibles does not justify a strict prohibition of capitalizing such expenditures.

Analyzing actual, observable data therefore involves several conflicting additional considerations. In order to answer our research questions and focus on the pure accrual aspect of capitalization and tease out its implications, we do not consider actual R&D accounting in our analysis. We exclude any discretion in R&D accounting by creating two samples reflecting full expensing and capitalization, respectively.

The above studies are not able to answer the question why capitalization is beneficial. To the contrary, it may well be argued that the information needs of investors are just as well satisfied by disclosures in the management report or other means of communication. Analysts are supposed to make up for the deficiencies of accounting by closely analyzing such information.

The comparative approach of Zhao (2002) with a focus on different countries finds that the relative value relevance of R&D reporting is a function of both the reporting environments and the R&D accounting standards. Capitalizers in his study (France,

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[3] In a French-GAAP environment Cazavan-Jeny and Jeanjean (2006) find that firms that capitalize are smaller, more highly leveraged, less profitable, and have less growth opportunities concluding that the capitalization choice might be a self selection issue. In contrast to Australian studies their results show a negative association between capitalization and stock return, i.e. the market considers capitalization as bad news not expecting future benefits. However, the authors stress that this might be a special case because France has a low legal enforcement and as such managers may have a more opportunistic approach to the use of R&D capitalization (p. 40).

[4] For instance in IAS 38 par. 21 six criteria for development costs as measures for future economic benefits need to be cumulatively fulfilled to qualify as an intangible asset. IAS 38 par. 57 defines these criteria as: technical feasibility, intention to complete, ability to use or sell, future economic benefits, adequate resources, and ability to measure. In that respect, the recognition criteria for intangible assets are far more stringent than for tangible assets.

UK) provide more value relevant accounting information as opposed to expensers (Germany, USA) when controlling for differences between common law (UK, USA) and code law countries (France, Germany).

Treating investments like expenses causes distortions in the measurement of performance and capital. For example, Mahlich and Yurtoglu (2011) find that the above-average returns observable in the pharmaceuticals industry vanish when the previously expensed R&D is added back to capital. Experimental studies indicate that analysts are unable to fully capture the dynamic effects of not capitalizing intangible investments. Even when they are familiar with the problem of expensing intangible investments, the errors in forecasts increase considerably under such an accounting treatment as compared to capitalizing (Luft and Shields 2001). Capitalizing can help in making more accurate forecasts.

Value relevance studies use market values as the benchmark which accounting data are intended to explain. This approach assumes that all publicly available information is included in market values. This leaves no room for an analysis on where the information included in prices originally came from, from the accounting or other sources. In addition, many of these studies use adjusted data, that is, manipulate the published data to reflect R&D capitalization (e.g. Lev and Sougiannis 1996). It is thus unclear *why* capitalization results in superior market value explanatory power in these studies. Obviously, the market must be informed about the prospects of R&D expenditures in order to value their potential.

Empirical studies have shown that firms provide additional information on intangibles (e.g. Abhayawansa and Guthrie 2010; Guthrie 2001). For German firms, Intellectual Capital Reporting has become an important means to communicate with the market (Edvinsson and Kivikas 2007). The German Commercial Code requires firms to analyze future developments concerning all relevant opportunities and threats (§289 HGB), in particular R&D activities (§315 II HGB), as part of the management report. GAS 15 gives guidance regarding the details of such a reporting. Ewelt and Knauer (2010) find that all HDAX firms give information on the prospects of their R&D projects in the narrative part of their annual reports. Similar results are found by Ruhwedel and Schultze (2002) for the DAX 100 firms. Other means of communication also likely transfer information on R&D projects to the market. Market values thus reflect the information collected from various sources other than accounting earnings. If R&D capitalization is more closely associated with market values than R&D expensing, market participants likely process the available information in a way which is consistent with R&D capitalization. This indicates that it is useful to market participants to apply accrual procedures to arrive at performance forecasts and value estimates.

When R&D expenditures are treated as assets and amortized over the estimated useful life, the costs are matched against the revenues generated from them, which is known as accrual accounting. This basic concept has been demonstrated in prior empirical research to have superior predictive properties as compared to cash flow accounting, i.e. the immediate, expensing of expenditures. We therefore assume that it is the accrual process that explains the increase in value relevance of financial information when capitalizing R&D.

2.2 Accrual versus cash accounting

Fundamentally, there are two different accounting concepts: cash accounting and accrual accounting. Cash accounting is only used by some very small companies, not differentiating between a short-term and a long-term view. Cash accounting focuses on inflows and outflows of cash effectively occurring during the considered period and neglects possible future effects. In contrast, GAAP are widely based on accrual accounting. In Statement of Financial Accounting Concepts No. 1 (1978) the FASB states that '*...Information about enterprise earnings and its components measured by accrual accounting generally provides a better indication of enterprise performance than does information about current cash receipts and payments*'.

Hence, 'accrual accounting is at the heart of earnings measurement and financial reporting' (Barth et al. 1999, p. 205). Various empirical studies compare the value relevance of earnings relative to cash flows, in order to analyze which of the two is able to better explain a firm's stock returns. Present earnings are derived from present cash flows via the accrual process. As a consequence, the accrual process itself is often regarded a result of trading off relevance and reliability (Dechow 1994). The accrual process allows us to calculate the earnings of the period by matching expenses and revenues occurred in the same period.

The definition of accruals proposed by Healy (1985) has been widely used in the accounting literature. He defines accruals as the difference between reported earnings and cash flows from operations. Besides, he decomposes total accruals into discretionary and non discretionary accruals, explaining the association between managers' accrual- and accounting procedure-decisions and their bonus plans based on accounting earnings. Based on this definition ($Earnings = Accruals + Cash\ Flows$), numerous studies investigate the question whether and under which circumstances earnings or cash flows better explain stock returns or better forecast future cash flows (see Dechow 1994; Lev and Zarowin 1999). Bowen et al. (1987) extend this approach by differentiating between cash flow from operations and cash flow after investment activities. By doing so, they expect to mitigate collinearity problems.

In essence, this discussion on the benefits of accrual accounting is identical to the question whether capitalizing intangible investments is beneficial. Capitalizing and amortizing R&D equals accrual accounting whereas immediately expensing R&D equals cash accounting. We therefore use the methodology applied in the value relevance studies dealing with accruals versus cash flows in order to provide evidence that R&D expenditures contain incremental information which explain market value. We expect that the additional explanatory power is due to the accrual component arising from treating R&D expenditures as assets.

In her seminal paper, Dechow (1994) demonstrates a greater association of accounting earnings with firm value, compared to cash flows. Also, a strong negative relation between accruals and cash flows is established. The regressions include stock returns as dependent variable and as independent variables: earnings, cash flow from operations, and net cash flow as the change in the balance of the cash account. She compares the explanatory power of the univariate regressions of either independent variable for stock returns. Her results indicate that accruals improve the ability of earnings to measure firm performance and to forecast future cash flows. She refers this to accruals improving the association of earnings with contemporaneous stock returns by mitigating the timing and matching problems of cash flows.

Barth et al. (1999) show that accruals are a value relevant component of earnings and help to explain the market value of equity. In contrast to prior research surrounding the valuation implications of the accrual and cash flow components of earnings (Bernard and Stober 1989; Bowen et al. 1987; Dechow 1994; Rayburn 1986; Wilson 1986, 1987), they utilize the framework of Ohlson (1999). They provide evidence that both the accrual and cash flow components of earnings have incremental information content in a valuation model including equity book value and abnormal earnings.

Barth et al. (2001b) provide evidence that the decomposition of total accruals into its major components significantly improves the prediction of future cash flows, as each accrual reflects different information concerning future cash flows. Their most comprehensive decomposition subdivides earnings into cash flows and the following accrual components: change in accounts receivable, change in accounts payable, change in inventory, depreciation, amortization, and other accruals. They show that the highest decomposition results in the least mean prediction errors. Based on the framework of Dechow et al. (1998) they demonstrate that a combination of accrual and net cash flow is superior compared to aggregated earnings in forecasting future cash flows. In contrast to prior studies, they show that all accrual components, including non-current accruals, aid in forecasting future cash flows. Similarly, Barth et al. (2005) analyze the predictive ability of decomposed earnings for equity values and find that disaggregated earnings reduce mean prediction errors.

Accruals can be differentiated according to their time horizon, i.e. whether they refer to current or non-current assets. Dechow (1994) focuses on short-term accruals to show higher explanatory power of earnings. Guay and Sidhu (2001) extend Dechow (1994) and provide evidence that non-current accruals reduce timing and matching problems in cash flows as is the case for current accruals. They show that due to longer intervals, the economic and statistical properties vary between short- and long-term accruals. Thus, non-current accruals also improve the usefulness of earnings.

In summarizing, we can conclude that, based on prior evidence, accruals provide incremental information over cash flows which help in predicting future performance and equity values. It is likely that this also holds true for R&D accounting.

2.3 Hypothesis development

As established above, empirical studies have found R&D capitalization to have superior market value explanatory power compared to expensing. As pointed out by Holthausen and Watts (2001), value relevance research does not allow to derive direct policy recommendations from it. Higher market value explanatory power does not suggest that R&D capitalization is a better form of accounting. Rather, the results indicate that market participants process publicly available information from various sources to arrive at value estimates that are more consistent with R&D capitalization than expensing. This suggests that it is useful to market participants to apply such procedures to arrive at performance forecasts and value estimates. As the results of the accrual literature establish, accruals help in predicting future performance. When

R&D expenditures are treated as assets and amortized over the estimated useful life, the costs are matched against the revenues generated from them. This process results in accrual information which is richer than cash information. We therefore assume that accruals also aid in valuing R&D. At the same time, the information included in R&D capitalization is already available to the market as 'other information' through other channels than accounting. Especially in all studies using adjusted accounting data (e.g. Lev and Sougiannis 1996), the market therefore has not received the information via accounting but from other sources. If manipulating the accounting data ex post to reflect R&D capitalization results in increased market value explanatory power, it is likely that R&D capitalization captures other publicly available information and internalizes it into the accounting. This may still improve the explanatory power of accounting figures because accruals better explain future performance than cash flows. We therefore expect that the additional explanatory power when capitalizing R&D is due to the accrual component arising from treating R&D expenditures as assets (the net effect of R&D amortization minus R&D capitalization). We test the following hypotheses (stated in the alternative form):

H1: *Financial information based on R&D capitalization shows higher association with market values than financial information based on adjusted full R&D expensing*.

H2: *Decomposing earnings into its cash flow and accrual components augments the explanatory power of book values and earnings for market values*.

H3: *The additional R&D accrual component resulting from R&D capitalization, adds explanatory power for market values*.

We expect that accruals extend the information content of cash flows, as a more primitive concept, to obtain earnings that are more useful over finite intervals. Our approach is consistent with Abrahams and Sidhu (1998), who also investigate the role of R&D capitalization in firm valuation and performance measurement using an Australian sample. They show that 'R&D accruals (particularly the initial capitalization) improve accounting earnings as a measure of performance [...]' (p. 169).

We test our predictions based on an approach derived from Dechow (1994) and Barth et al. (2005) and based on the Ohlson (1995) model, which captures 'other information', that is, information included in market values but not explained by accounting variables. The above rationale implies that capitalizing R&D captures information that is otherwise included in 'other information'. The relative importance of 'other information' should therefore decrease when R&D is capitalized. We expect the extent and weight of 'other information' in the expensing sample to exceed that of the capitalizing sample and hypothesize:

H4: *The weight and extent of 'other information' in a regression based on capitalized R&D is smaller than in a regression based on expensed R&D*.

3 Research design

To test the above hypotheses, we extend the framework of Dechow (1994) in several aspects. Firstly, the original model was based on a univariate regression of earnings as the independent variable. Collins et al. (1999) find that the simple earnings capitalization model is likely misspecified due to the correlated omitted variables problem and suggest including book value of equity in the regression. Book values can be considered relevant due to their role as a proxy for the abandonment or adaption value of net assets. Alternatively, the relevance of book values derives from the Ohlson (1995) model, where book value proxies for future normal earnings (Collins et al. 1999). The Ohlson model establishes a theoretical link between market values (MV), book values (BV), abnormal earnings (E^a), and 'other information' (ν):

$$MV_t = BV_t + \frac{\omega}{1+r-\omega} E_t^a + \frac{1+r}{(1+r-\omega)(1+r-\gamma)} \nu_t \tag{1}$$

where abnormal earnings follow an autoregressive process (linear information dynamics) which is linear in the parameter ω and 'other information'. 'Other information' follows a stochastic process where the parameter is γ; and r denotes the required rate for the opportunity cost of capital. From this relationship, a theoretical benchmark and interpretation for regression coefficients resulting from empirical applications of the model can be derived. The model provides a unifying theoretical framework for the empirical application of a large number of valuation models, which have previously often been formulated on an 'ad hoc' basis (Dechow et al. 1999, p. 32). While the basic model relates market values to book values, residual income, and 'other information', Ohlson (1995) explicitly considers different applications of this basic relationship. In particular, regressions relating market values to book values and earnings can be considered a special case of the general model (Ohlson 1995, pp. 670) where the parameter ω determines the weighted average between a pure earnings and a pure book value multiplier model. While $\omega = 0$ represents a pure book value multiplier model, $\omega = 1$ represents the simple earnings capitalization model frequently used in empirical research. For values of $0 < \omega < 1$, the model becomes a combination of the two and the interpretation of the regression coefficient changes from the original version (Ohlson 1995, p. 671; also Dechow et al. 1999, p. 24):

$$MV_t = \left(1 - \frac{r\omega}{1+r-\omega}\right) BV_t + \frac{\omega + r\omega}{1+r-\omega} E_t - \frac{r\omega}{1+r-\omega} Div_t \tag{2}$$

Or, respectively:

$$MV_t = \frac{1-\omega}{1+r-\omega} BV_{t-1} + \frac{1}{1+r-\omega} E_t \tag{3}$$

This relationship establishes a theoretical link between market values, book values, dividends (DIV) and earnings rather than abnormal earnings. The economic intuition for this is that abnormal earnings differ from earnings by the cost of capital, which are made up of book values and the required rate of return. Book values already being included in the regression, the rate of return becomes part of the regression coefficient in a regression on earnings rather than abnormal earnings. Equation (3) can be used to derive benchmarks for interpreting regression coefficients based on historical values for ω. For example, Dechow et al. (1999) find that the historical estimate for ω is 0.62. At $r = 12\%$ this implies a coefficient of 0.76 on book values and 2 on earnings. They find deviations from their expectations, which they explain by analysts overestimating the persistence parameter ω.

In the following, we build our analysis on this relationship. Using earnings rather than abnormal earnings allows us to directly decompose earnings into cash flows (*CF*) and accruals (*ACC*):

$$MV_{it} = \alpha_1 BV_{it-1} + \alpha_2 E_{it} + \alpha_3 \nu_{it} + \varepsilon_{it} \tag{4}$$

$$MV_{it} = \alpha_1 BV_{it-1} + \alpha_2 CF_{it} + \alpha_3 ACC_{it} + \alpha_4 \nu_{it} + \varepsilon_{it} \tag{5}$$

We thus do not add additional information to the basic relationship of market values, book values, and earnings, but replace earnings by components of earnings. Any additional explanatory power thus only derives from this subdivision and the refinement achieved by being able to analyze the separate components. As previous research has shown, accruals and cash flows have different persistence and consequently receive different weights in valuation (Sloan 1996). Accordingly, the more differentiated analysis allows for additional explanatory power. Further, by manipulating earnings to reflect different forms of R&D accounting, we capture the extent to which information is included in earnings or 'other information'.

Our model decomposes earnings into cash flows and the main accrual components based on Barth et al. (2001b) and Barth et al. (2005). We include working capital accruals (*WCACC*) consisting of the change in accounts receivable, change in accounts payable, and change in inventory. In accordance with Richardson et al. (2005) we include non-current (long-term) accruals (*LTACC*) in our analysis, which are depreciation and amortization (*DEPAMORT*) as well as new investments in property, plant and equipment (*PPE*), intangibles (*INT*), and R&D. Traditional accrual versus cash flow studies only consider depreciation and amortization as non-current accruals. Including *LTACC* is important to our study, as investments in R&D are part of it. We introduce the accrual created by capitalizing R&D (*RDACC*) as a special long-term accrual generated by R&D capitalization, which represents the net effect of the annual R&D capitalization and amortization. We generate the R&D asset and the particular accrual obtained when capitalizing R&D: The R&D asset is recognized on the balance sheet and changes from period to period. The periodic change of the R&D asset is represented by *RDACC*, which is defined as R&D amortization less newly capitalized R&D.

Based on the framework of Dechow (1994) we argue that the value relevance of capitalizing R&D is attributed to the accrual component of earnings. We expect that the R&D capitalization leads to earnings that are more strongly associated with market capitalization than earnings obtained by expensing these expenditures.

We create two different samples, consisting of the same firms but different in their accounting for R&D. The expensing sample is based on data presuming full expensing of R&D for which we convert all companies under IFRS and US-GAAP with capitalized development costs in order to obtain a sample of expensed R&D. The second sample was modeled to allow for capitalization of all R&D costs. Because our aim is to investigate the accrual consequences of capitalization, we do not allow for partial capitalization. For the amortization adjustments we presume a constant amortization rate of 20% per year for capitalized R&D based on other studies such as Lev et al. (2005), who determine five years as the expected useful life for R&D. We further assume a basis of the R&D assets capitalized in prior periods as the mean of all R&D costs over the period 2001–2006 multiplied by 1/amortization rate of 20%.

Table 1 Differences between the expensing and the capitalizing sample

Variable	Expensing sample	Capitalizing sample
E	E^{exp}	$E^{cap} = E^{exp} - RDACC = E^{exp} + RDINV$ $-RDAMORT$
OCF	$OCF^{exp} =$ $E^{exp} + DEPAMORT + WCACC$	$OCF^{cap} =$ $OCF^{exp} + RDINV$
ICF	ICF^{exp}	$ICF^{cap} = ICF^{exp} + RDINV$
FCF	FCF	FCF
$WCACC$	$WCACC$	$WCACC$
$DEPAMORT$	$DEPAMORT$	$DEPAMORT$
$LTACC$	$LTACC^{exp}$	$LTACC^{cap} = LTACC^{exp} + RDINV + RDAMORT$
$RDACC$	*N/A*	$RDACC$
BV	BV^{exp}	$BV^{cap} = BV^{exp} + RDA$

With E for earnings, OCF for operating cash flow, ICF for investing cash flow, FCF for free cash flow, $WCACC$ for working capital accruals ($= \Delta accounts\ receivable + \Delta inventory - \Delta accounts\ payable$), $DEPAMORT$ for depreciation and amortization, $LTACC$ for long-term accruals, $RDACC$ for R&D accruals (R&D amortization $RDAMORT$ − capitalized R&D expenditures $RDINV$), RDA for R&D asset, and BV for book value of equity

This allows us to assume that, on average, investment and amortization of R&D occur steadily. Table 1 gives an overview of the manipulations to the data and depicts the differences in the variables of the two samples.

Only E and $LTACC$ are affected by $RDACC$, and BV by RDA. FCF is not affected by different accounting for R&D: the effects on OCF and ICF by $RDINV$ cancel out and the value of FCF remains the same after capitalizing R&D. Consistent with prior research (e.g. Barth et al. 2001b, 2005; and Dechow and Ge 2006), we use the balance sheet approach to determine the accrual components of earnings. This is consistent with our above definition of accruals represented by the change in the R&D asset.[5]

We compare the explanatory power of book values and earnings between these two samples. As the two samples comprise the same firms, differences between the two regressions are solely attributable to differences in R&D accounting. We decompose earnings step by step and receive three different regression models per sample:[6]

LIM$_1$ (expenser):

$$MV_{it} = \alpha_0 + \alpha_1 E_{it}^{\exp} + \alpha_2 BV_{it-1}^{\exp} + \alpha_3 v_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (6)$$

[5]Note that the balance sheet approach might lead to measurement errors in accrual estimates if mergers and acquisitions, discontinued operations, foreign currency translations, and divestitures occur as examined in Hribar and Collins (2002). They find that this is particularly the case if the aim is to analyze earnings management, to estimate discretionary and nondiscretionary accruals, and to detect accruals anomaly. However, Fairfield et al. (2003) find no difference in their results when eliminating approximately 12,000 firm-years affected by these transactions. Due to our small sample size and to avoid survivorship bias we include these firm-years.

[6]In order to consider firm fixed effects, we include the variable α_i which captures firm fixed effects and leads to firm specific intercepts, with $\alpha_i = \beta_0 + \beta_1 Z_i$ (holding constant the unobserved firm characteristics Z). α_t is included in the regression for year fixed effects.

with: MV = Markt value measured by market capitalization; E^{exp} = Earnings (expensing sample); BV^{exp} = Book value (expensing sample); ε_{it} = disturbance term.

The capitalizing sample is adjusted so that book values and earnings reflect capitalization of all R&D expenditures:

LIM$_1$ (capitalizer):

$$MV_{it} = \alpha_0 + \alpha_1 E_{it}^{cap} + \alpha_2 BV_{it-1}^{cap} + \alpha_3 v_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \qquad (7)$$

with: E^{cap} = Earnings (capitalizing sample); BV^{cap} = Book value (capitalizing sample).

As in Barth et al. (2005), 'other information' ν_{it} is proxied by the difference between lagged market value and its fitted value based on the regression estimate of the respective LIM without ν. It is defined as: $\nu_{it} = MV_{it-1} - \mathit{fitted}(MV_{it-1})$. Essentially, this definition captures all information included in market prices but not explained by the accounting variables included in the regression (Barth et al. 2005, p. 315).

LIM$_2$ and LIM$_3$ disaggregate earnings into its major cash flow and accrual components. To derive a formal description of the relationship between cash flows, accruals, and earnings, we make use of the elements of the cash flow statement. *NCF* can be split into its components, cash from operations (*OCF*), investing (*ICF*), and financing activities (*FinCF*):

$$NCF = OCF + ICF + FinCF$$

Cash from operating activities can be calculated from earnings by adding back depreciation and amortization (*DEPAMORT*) and changes in net working capital (*WCACC*). From this, the following relationships hold for the expensing sample:[7]

$$\begin{aligned} FCF &= OCF^{exp} + ICF^{exp} \\ OCF^{exp} &= E^{exp} + DEPAMORT + WCACC \\ ICF^{exp} &= PPE\_INV + INT\_INV \\ LTACC^{exp} &= DEPAMORT + PPE\_INV + INT\_INV \\ FCF &= E^{exp} + LTACC^{exp} + WCACC \end{aligned}$$

with: *FCF* = Free cash flow; *OCF* = Cash flow from operations; *ICF* = Cash flow from investing activities; *DEPAMORT* = Depreciation and amortization; *WCACC* = Working capital accruals (Δ*accounts receivable* + Δ*inventory* − Δ*accounts payable*); *PPE_INV* = Investments in PPE; *INT_INV* = Investments in intangibles (other than R&D); *LTACC* = Long-term accruals.

[7] The sign of all cash flows depends on the direction of the cash flows, that is, outflows are negative and inflows are positive. Cash flows attributable to investment activities like for PPE (*PPE_INT*) and intangible assets (*INT_INV*) regularly carry a negative sign for being cash outflows. The same applies for *RDINV* as another investing activity. Hence, the aggregate of all cash flows from investing activities will most often be negative as well. The descriptive statistics show that the mean values for these variables are negative. To calculate cash flow from earnings, expenses which are not cash flows at the same time need to be added back to earnings to compute cash flows. They are positively defined to express the computation of cash flows.

Substituting earnings in (6) by its equivalent consisting of free cash flow plus accruals yields the first decomposition:

LIM$_2$ (expenser):

$$MV_{it} = \alpha_0 + \alpha_1 FCF_{it} + \alpha_2 LTACC^{\text{exp}}_{it-1} + \alpha_3 WCACC_{it} + \alpha_4 BV^{\text{exp}}_{it-1} + \alpha_5 v_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (8)$$

The capitalizing sample requires adjustments for the calculation of E, BV, OCF, and ICF:

$$\begin{aligned}
E^{cap} &= E^{exp} + RDINV - RDAMORT \\
BV^{cap} &= BV^{exp} + RDA \\
OCF^{cap} &= E^{exp} + DEPAMORT + WCACC + RDINV \\
ICF^{cap} &= PPE_INV + INT_INV + RDINV \\
LTACC^{cap} &= LTACC^{exp} + RDINV + RDAMORT \\
&= DEPAMORT + PPE_INV + INT_INV + RDINV + RDAMORT \\
&= DEPAMORT + RDAMORT + ICF^{cap} \\
RDACC &= RDAMORT + RDINV \\
FCF &= E^{cap} + WCACC + DEPAMORT + RDAMORT + ICF^{cap} \\
&= E^{cap} + WCACC + LTACC^{cap}
\end{aligned}$$

with: $RDAMORT$ = R&D amortization; $RDINV$ = Investments in R&D; $RDACC$ = R&D accrual; RDA = R&D asset.

Substituting the latter into (7) leads to LIM$_2$ for the capitalizing sample:

LIM$_2$ (capitalizer):

$$MV_{it} = \alpha_0 + \alpha_1 FCF_{it} + \alpha_2 LTACC^{cap}_{it-1} + \alpha_3 WCACC_{it} + \alpha_4 BV^{cap}_{it-1} + \alpha_5 v_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (9)$$

In a further step, $LTACC$ can be disaggregated into its components. Substituting

$$LTACC^{exp} = DEPAMORT + PPE\_INV + INT\_INV$$

into (8) and rearranging yields:

LIM$_3$ (expenser):

$$MV_{it} = \alpha_0 + \alpha_1 OCF^{\text{exp}}_{it} + \alpha_2 DEPAMORT_{it} + \alpha_3 WCACC_{it} + \alpha_4 BV^{\text{exp}}_{it-1} + \alpha_5 v_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (10)$$

$LTACC^{cap}$ can be disaggregated into its components:

$$\begin{aligned}
FCF &= E^{cap} + WCACC + DEPAMORT + RDAMORT + ICF^{cap} \\
FCF &= E^{cap} + WCACC + DEPAMORT + RDAMORT + ICF^{exp} + RDINV \\
FCF &= E^{cap} + WCACC + DEPAMORT + ICF^{exp} + RDACC \\
E^{cap} &= OCF^{exp} - DEPAMORT - WCACC - RDACC
\end{aligned}$$

The resulting decomposition of earnings is substituted into (7) to yield

LIM_3 (capitalizer):

$$MV_{it} = \alpha_0 + \alpha_1 OCF_{it}^{\exp} + \alpha_2 DEPAMORT_{it} + \alpha_3 RDACC_{it} + \alpha_4 WCACC_{it} + \alpha_5 BV_{it-1}^{cap} + \alpha_6 v_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (11)$$

In order not to reject hypothesis 1, we assume the financial information based on the capitalized data to contain higher value relevance for both LIM_1 and LIM_3 than based on the expensed data. Thus, the market value explanatory power of the analyzed LIMs is expected to show the following relationships:

$$\text{LIM}_\text{i}(\text{exp}) < \text{LIM}_\text{i}(\text{cap})$$

To test hypothesis 2, we expect that the explanatory power of each LIM increases the further earnings are decomposed, that is:

$$\text{LIM}_1(\text{exp}) < \text{LIM}_2(\text{exp}) < \text{LIM}_3(\text{exp})$$
$$\text{LIM}_1(\text{cap}) < \text{LIM}_2(\text{cap}) < \text{LIM}_3(\text{cap})$$

In order to test hypothesis 3, we expect that the coefficient α_3 on *RDACC* in LIM_3 is positive and significant.[8] For hypothesis 4, we expect that the coefficient on 'other information' v in each LIM is smaller for the capitalizing sample. Also, we expect that the level of 'other information', measured by the mean of absolute values of 'other information' is smaller for the capitalizing sample.

4 Sample selection and descriptive statistics

Our sample consists of the 150 largest German public firms listed in the H-DAX for the years 2001–2006. We exclude financial institutions due to their unique accounting and firm-year observations with no R&D expenditures during the sample period, resulting in 537 observations. We further lose 118 firm-year observations due to missing data because the calculation of 'other information' is based on lagged information. Our final sample size is 419 observations across all analyses. The companies' reporting is based on German GAAP, where the capitalization of R&D is prohibited, IFRS with partial capitalization of development costs (IAS 38), or US-GAAP with partial capitalization of software development costs (SFAS 86). The analysis of R&D requires a careful study of the disclosures of companies' financial statements. The information about the amount of all R&D expenditures (i.e. all R&D either to be capitalized or expensed) is not available via data bases. In order to keep the sources of data consistent in our analyses, all other financial information is also hand-collected. Only for market information, we obtained share price data from datastream.

Tables 2 and 3 present descriptive statistics for the variables used in the estimation equations. All variables are scaled by total assets at the beginning of fiscal year.

[8] As noted above, investments in R&D are cash outflows and carry a negative sign. *RDACC* mostly are negative leading to a negative mean of -0.02 (see Table 1). For ease of interpretation we multiply the coefficient on *RDACC* in our regressions with -1 to demonstrate the positive association with market values.

Table 2 Distributional statistics

Variable	Mean	Median	Std. Dev.
Panel A: Expensing sample ($n = 419$)			
MV	1.083	0.593	1.360
E^{exp}	0.103	0.040	1.280
FCF	0.145	0.048	1.473
ICF^{exp}	0.073	0.052	0.209
OCF^{exp}	0.218	0.105	1.417
WCACC	0.028	−0.001	0.738
DEPAMORT	0.060	0.038	0.274
BV^{exp}	0.524	0.430	1.067
$OTHER^{exp,LIM3}$	−0.116	−0.428	1.113
Panel B: Capitalizing sample ($n = 419$)			
MV	1.083	0.593	1.360
E^{cap}	0.123	0.056	1.279
FCF	0.145	0.048	1.473
ICF^{cap}	0.116	0.088	0.226
OCF^{cap}	0.261	0.137	1.414
WCACC	0.028	−0.001	0.738
DEPAMORT	0.060	0.038	0.274
RDINV	0.042	0.021	0.067
RDAMORT	0.023	0.011	0.033
RDACC	−0.020	−0.008	0.038
BV^{cap}	0.617	0.491	1.081
$OTHER^{cap,LIM3}$	0.050	−0.164	1.083

Table 2 presents descriptive statistics of the variables used in the multiple regression analyses. Panel A displays mean, median, and standard deviation values for the expensing sample and Panel B for the capitalizing sample. Differences between the samples in the values of the variables are denoted by the corresponding superscripts. All variables are deflated by total assets at the beginning of fiscal year and winsorized at the top 1% level. The variables comprise *MV* for market value of equity, *E* for earnings, *FCF* for free cash flow, *ICF* for investing cash flow, *OCF* for operating cash flow, *WCACC* for working capital accruals ($= \Delta$*accounts receivable* $+ \Delta$*inventory* $- \Delta$*accounts payable*), *DEPAMORT* for depreciation and amortization, *RDINV* for annual R&D expenditures, *RDAMORT* for R&D amortization, *RDACC* for R&D accruals (*RDAMORT* − *RDINV*), and *BV* for book value of equity. *OTHER* is the estimation of 'other information' in the LIM_3 model consistent with Barth et al. (2005): $OTHER = MV_{t-1} - fitted(MV_{t-1})$, with $fitted(MV_{t-1})$ as the fitted value of MV_{t-1} based on LIM_3 excluding 'other information'

The results of the distributional statistics are consistent with prior research (e.g. Barth et al. 2005; Richardson et al. 2005). Comparing the expensing and capitalizing sample we find overall higher amounts for *E*, *BV*, and *ICF* using the capitalized data, which is due to *RDACC*. The results also reveal that, on average, the market values of equity exceed book values, indicating that book value is insufficient to explain market value. By allowing full capitalization of R&D, the gap between mean market value and book value diminishes. Additionally, our findings are consistent with Guay

Table 3 Pearson correlation matrix for independent variables of LIM_3

Panel A: Expensing sample

$n = 419$	OCF^{exp}	$WCACC$	$DEPAMORT$	BV^{exp}	$OTHER^{exp,LIM3}$
OCF^{exp}	1				
$WCACC$	0.409[b]	1			
$DEPAMORT$	0.355[b]	−0.032	1		
BV^{exp}	0.174[b]	−0.214[b]	−0.021	1	
$OTHER^{exp,LIM3}$	0.115[a]	−0.175[b]	0.051	0.265[b]	1

Panel B: Capitalizing sample

$n = 419$	OCF^{cap}	$WCACC$	$DEPAMORT$	$RDACC$	BV^{cap}	$OTHER^{cap,LIM3}$
OCF^{cap}	1					
$WCACC$	0.375[b]	1				
$DEPAMORT$	0.360[b]	−0.032	1			
$RDACC$	0.130[b]	0.072	−0.029	1		
BV^{cap}	0.269[b]	−0.227[b]	−0.017	−0.514[b]	1	
$OTHER^{cap,LIM3}$	0.170[b]	−0.190[b]	0.081	−0.031	0.152[b]	1

Table 3 presents the pearson correlation matrix for the independent variables of LIM_3. All variables are deflated by total assets at the beginning of fiscal year and winsorized at the top 1% level. Panel A displays the correlations for the expensing sample and Panel B for the capitalizing sample. Differences between the samples in the values of the variables are denoted by the corresponding superscripts. The variables comprise *OCF* for operating cash flow, *WCACC* for working capital accruals ($= \Delta accounts\ receivable + \Delta inventory - \Delta accounts\ payable$), *DEPAMORT* for depreciation and amortization, *RDACC* for R&D accruals (R&D amortization − R&D expenditures), *BV* for book value of equity at fiscal year end, and *OTHER* for the estimation of 'other information' for the capitalizing sample in the LIM_3 model consistent with Barth et al. (2005): $OTHER = MV_{t-1} - fitted(MV_{t-1})$, with $fitted(MV_{t-1})$ as the fitted value of MV_{t-1} based on LIM_3 excluding 'other information'

[a]Correlation is significant at the 0.05 level (2-tailed)

[b]Correlation is significant at the 0.01 level (2-tailed)

and Sidhu (2001) as the standard deviation of earnings is smaller than the standard deviation of operating cash flows in both samples. This signals that accruals reduce the volatility of cash flows as shown by Dechow (1994).

Table 3 presents the pair-wise correlation-coefficients of the independent variables for LIM_3 of both samples. The results only show significantly high correlations above 30% between *OCF* and the two variables *WCACC* and *DEPAMORT* for both samples. For the capitalizing sample, the correlation between *BVCAP* and *RDACC* is also relatively higher with a correlation coefficient of 50%. However, the analyses of VIFs displayed in the following tables are below the conservative threshold of five and show no indication of multicollinearity problems. All variables are deflated by lagged total assets and winsorized at the top 1% level to reduce any biases from outliers.

5 Empirical results

For the multiple regression analyses of our panel data we use fixed effects models. The results of the Hausman specification test are presented in Table 4 and show significant p-values for both the expensing and capitalizing sample. The results indicate that the random effects model is not appropriate and suggest the use of the fixed effects model.[9]

Table 5 presents the regression results of LIM_1. Panel A shows highly significant and positive coefficients for both earnings and book value for the expensing sample. Similar findings can be observed in Panel B for the sample with earnings and book value figures reflecting R&D capitalization. Consistent with our expectations in Sect. 3, the regression coefficient for earnings takes on a value around 2. The coefficient on book values is substantially larger than 1, indicating that book values receive a much larger weight than predicted by theory. This observation is consistent with book values being biased downward by conservative accounting (Penman and Zhang 2002). We see from the high F-Values that the models are highly significant. Likewise the determination coefficients above 40% are high, indicating strong explanatory power of the models. The higher R^2 within for LIM_1 for the capitalizing sample (44.39%) compared to the expensing sample (41.75%) suggests higher market value explanatory power of earnings when R&D is capitalized.

To test for a significance of this difference in explanatory power, we conduct the Vuong (1989) likelihood ratio test for model selection without presuming under the null hypothesis that either model is 'true' (Dechow 1994, p. 23). The Vuong Z-Statistic identifies the financial information (earnings and book value including capitalized R&D versus including expensed R&D) which is closer to explaining market value. Both models have explanatory power, but the test statistic provides direc-

Table 4 Hausman specification test

	Chi^2	p-Value
LIM_1^{exp}	18.60	0.009
LIM_1^{cap}	14.79	0.038
LIM_2^{exp}	23.73	0.004
LIM_2^{cap}	23.70	0.004
LIM_3^{exp}	23.11	0.010
LIM_3^{cap}	21.44	0.029

Table 4 presents the results of the Hausman Specification Test for LIM_1–LIM_3. The Hausman test compares a more efficient model (random effects model) against a less efficient but consistent model (fixed effects model) to validate that the more efficient model gives consistent results. The underlying null hypothesis is that the estimators of both the fixed and the random effects model do not differ substantially. Only when not rejecting the null, it is safe to use the random effects model

[9] For a detailed discussion on the Hausman specification test, see Baltagi (2005), pp. 66–74.

Table 5 Regression results for LIM_1

Panel A: Expensing sample

				Regression results	
R^2 within (%)				41.75	
AIC				696.59	
SIC				728.89	
Standard error				0.631	
Observations				419	
F-value				31.95	
Highest VIF				1.63	
Firm fixed effects				Yes	
Year fixed effects				Yes	
Dependent variable				*MV*	
	Pred. sign	Coefficients	Standard error	t-Statistics	p-Value
E^{exp}	+	2.068	0.455	4.54	0.000
BV^{exp}	+	1.682	0.148	11.35	0.000
$OTHER^{exp,LIM1}$	?	0.216	0.055	3.91	0.000
Const.		0.540	0.103	5.22	0.000

Panel B: Capitalizing sample

				Regression results	
R^2 within (%)				44.39	
AIC				677.15	
SIC				709.45	
Standard error				0.617	
Observations				419	
F-value				35.58	
Highest VIF				1.65	
Firm fixed effects				Yes	
Year fixed effects				Yes	
Dependent variable				*MV*	
	Pred. sign	Coefficients	Standard error	t-Statistics	p-Value
E^{cap}	+	2.552	0.464	5.50	0.000
BV^{cap}	+	1.783	0.144	12.31	0.000
$OTHER^{cap,LIM1}$	?	0.183	0.052	3.48	0.001
Const.		0.275	0.113	2.42	0.016

Table 5 (*Continued*)

Panel C: Vuong likelihood ratio test (LIM 1)		
Model selection	Vuong's Z-statistic	p-Value
LIM_1 (expensing) vs. LIM_1 (capitalizing)	−2.48	0.065

Table 5 presents regression results for LIM_1 (p-values are one-tailed if sign predicted, two-tailed otherwise). Panel A displays results for the expensing sample and Panel B for the capitalizing sample. Differences between the samples in the values of the variables are denoted by the corresponding superscripts. Panel C shows the Vuong's Z-statistic (one-tailed) for significant differences between the results in Panel A versus Panel B. All variables are deflated by total assets at the beginning of fiscal year and winsorized at the top 1% level. The dependent variable is *MV* for market value of equity. The independent variables comprise E for earnings, BV for book value of equity, and *OTHER* is the estimation of 'other information' in the LIM_1 model: $OTHER = MV_{t-1} - fitted(MV_{t-1})$, with $fitted(MV_{t-1})$ as the fitted value of MV_{t-1} based on LIM_1 excluding 'other information'

tion concerning which model is closer to the 'true data generating process'.[10] A negative Z-statistic indicates that the residuals produced by LIM_1 from the expensing sample are larger than those produced by LIM_1 from the capitalizing sample. Panel C of Table 5 shows a negative Z-statistic significant at 0.10 (-2.48, $p = 0.065$) identifying LIM_1 including financial information based on capitalized R&D data as the model of choice. The Akaike (AIC) and Schwarz information criteria (SIC) are further model selection criteria which consider the idea of penalization when adding regressors.[11] In comparing the two models, the model with the lower value of AIC or SIC is preferred. The results of these model selection criteria are consistent with our previous findings using R^2 within. Both AIC and SIC are lower for the model using the capitalizing sample compared to using the expensing sample (AIC: $677.15 < 696.59$ and SIC: $709.45 < 728.89$). All model selection criteria suggest that by capitalizing R&D, adjusted aggregate earnings have stronger explanatory power compared to aggregate earnings under an expensing regime. The results allow us to confirm our hypothesis 1: capitalizing R&D leads to earnings and book values with superior market value explanatory power. Table 5 Panel A also shows that the regression coefficient of *OTHER* for the expensing sample is positive and significant at 0.01 with a value of 0.216. In Panel B for the capitalizing sample, the coefficient decreases to 0.183 suggesting a lower weight of 'other information' when R&D expenditures are capitalized.

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[10] The Vuong Z-Statistic is defined as $Z = \frac{1}{\sqrt{n}} \frac{LR}{\hat{\omega}}$, with simplified LR_i for each observation i: $LR_i = \frac{1}{2}\log[\frac{RSS_{cap}}{RSS_{\exp}}] + \frac{n}{2}[\frac{(e_{cap_i})^2}{RSS_{cap}} - \frac{(e_{\exp_i})^2}{RSS_{\exp}}]$ and the standard deviation of LR: $\hat{\omega}$. The likelihood ratio test (LR) is based on the residuals of the corresponding LIMs (e), the residual sum of squares (RSS), and the number of observations in the analyses (n). For a detailed discussion on the Vuong Test, see Dechow (1994), Appendix 2, pp. 37–40.

[11] According to R^2 both information criteria are defined based on RSS with $\ln AIC = (\frac{2k}{n}) + \ln(\frac{RSS}{n})$ and $\ln SIC = \frac{k}{n}\ln n + \ln(\frac{RSS}{n})$, with n observations and k regressors. *SIC* imposes even greater penalty when adding regressors compared to *AIC*, see Gujarati (2003, p. 536).

Table 6 Regression results for LIM_2

Panel A: Expensing sample					
					Regression results
R^2 within (%)					45.95
AIC					669.25
SIC					709.63
Standard error					0.610
Observations					419
F-value					29.28
Highest VIF					1.95
Firm fixed effects					Yes
Year fixed effects					Yes
Dependent variable					*MV*
	Pred. sign	Coefficients	Standard error	t-Statistics	p-Value
FCF	+	0.478	0.192	2.49	0.000
$LTACC^{exp}$	–	−0.736	0.398	−1.85	0.033
WCACC	–	−1.694	0.474	−3.57	0.000
BV^{exp}	+	1.351	0.129	10.47	0.000
$OTHER^{exp,LIM2}$	?	0.248	0.055	4.44	0.000
Const.		0.617	0.094	6.51	0.000

Panel B: Capitalizing sample					
					Regression results
R^2 within (%)					48.51
AIC					648.91
SIC					689.29
Standard error					0.595
Observations					419
F-value					32.45
Highest VIF					2.09
Firm fixed effects					Yes
Year fixed effects					Yes
Dependent variable					*MV*
	Pred. sign	Coefficients	Standard error	t-Statistics	p-Value
FCF	+	0.492	0.190	2.59	0.005
$LTACC^{cap}$	–	−0.668	0.367	−1.82	0.035
WCACC	–	−1.457	0.467	−3.12	0.001
BV^{cap}	+	1.688	0.149	11.28	0.000
$OTHER^{cap,LIM2}$	?	0.205	0.053	3.87	0.000
Const.		0.272	0.111	2.44	0.015

Table 6 (*Continued*)

Panel C: Vuong likelihood ratio test (LIM 2)		
Model selection	Vuong's Z-statistic	p-Value
LIM_2 (expensing) vs. LIM_2 (capitalizing)	−1.66	0.049

Table 6 presents regression results for LIM_2 (p-values are one-tailed if sign predicted, two-tailed otherwise). Panel A displays results for the expensing sample and Panel B for the capitalizing sample. Differences between the samples in the values of the variables are denoted by the corresponding superscripts. Panel C shows the Vuong's Z-statistic (one-tailed) for significant differences between the results in Panel A versus Panel B. All variables are deflated by total assets at the beginning of fiscal year and winsorized at the top 1% level. The dependent variable is *MV* for market value of equity. The independent variables comprise *FCF* for free cash flow, *LTACC* for long-term accruals ($= \textit{investing cash flow} + \textit{depreciation/amortization}$), *WCACC* for working capital accruals ($= \Delta\textit{accounts receivable} + \Delta\textit{inventory} - \Delta\textit{accounts payable}$), *BV* for book value of equity, and *OTHER* is the estimation of 'other information' in the LIM_2 model: $\textit{OTHER} = MV_{t-1} - \textit{fitted}(MV_{t-1})$, with $\textit{fitted}(MV_{t-1})$ as the fitted value of MV_{t-1} based on LIM_1 excluding 'other information'

These results remain valid when we decompose earnings into its components, as is done in LIM_2 and LIM_3. The results for LIM_2 are presented in Table 6.

The results again show higher R^2 within and lower AIC and SIC for the capitalizing sample. R^2 within of LIM_2 for the expensing sample takes on a value of 45.95%. The Vuong Z-statistic in Panel C of Table 6 shows that the R^2 within of LIM_2 for the capitalizing sample with 48.51% is significantly higher (−1.66, $p = 0.049$). The regression coefficients are all significant with the predicted sign at the 0.01 level, except for *LTACC* being significant at 0.05 only. Consistent with prior literature (e.g. Guay and Sidhu 2001), the coefficients of *WCACC* and *LTACC* are negative while for *FCF* and *OTHER* they are positive. Note that the value of the regression coefficient of *OTHER* is again smaller for the capitalizing sample (0.205) compared to the expensing sample (0.248).

In LIM_3 in Table 7, earnings are further decomposed into operating cash flow, depreciation/amortization, working capital accruals, and in Panel B for the capitalizing sample, also R&D accruals. R^2 within for the expensing sample is 46.61%, which is significantly smaller than for the capitalizing sample with 49.40% (Z-Statistic in Panel C: −1.81 with $p = 0.035$). We confirm that also for disaggregated earnings, our findings are consistent with hypothesis 1.

Note that when moving from LIM_1 to LIM_2 and LIM_3, R^2 within increases while AIC and SIC decrease. Tables 6 and 7 show that for both the expensing and the capitalizing sample, disaggregating earnings into cash flow and accrual components in LIM_2 and LIM_3 leads to higher market value explanatory power relative to LIM_1, presented in Table 5 (46.61% and 45.95% versus 41.75% R^2 within for the expensing sample; 49.49% and 48.51% versus 44.39% for the capitalizing sample). This finding is consistent with the notion that disaggregated earnings yield more relevant information than aggregated earnings (e.g. Barth et al. 2005) and confirms our hypothesis 2.

The regression coefficient for *RDACC* in Panel B of Table 7 with a relatively high weight of 5.422 is positive and significant at 0.05. This finding is consistent with our

Table 7 Regression results for LIM 3

Panel A: Expensing sample

					Regression results
R^2 within (%)					46.61
AIC					664.07
SIC					704.45
Standard error					0.606
Observations					419
F-value					30.08
Highest VIF					1.81
Firm fixed effects					Yes
Year fixed effects					Yes
Dependent variable					MV

	Pred. sign	Coefficients	Standard error	t-Statistics	p-Value
OCF	+	0.694	0.230	3.01	0.000
DEPAMORT	–	−0.001	0.997	−0.00	0.499
WCACC	–	−2.006	0.500	−4.01	0.000
BV^{exp}	+	1.302	0.130	10.01	0.000
$OTHER^{exp,LIM3}$	?	0.255	0.055	4.58	0.065
Const.		0.611	0.097	6.29	0.000

Panel B: Capitalizing sample

					Regression results
R^2 within (%)					49.40
AIC					643.61
SIC					688.02
Standard error					0.591
Observations					419
F-value					30.17
Highest VIF					1.92
Firm fixed effects					Yes
Year fixed effects					Yes
Dependent variable					MV

	Pred. sign	Coefficients	Standard error	t-Statistic	p-Value
OCF	+	0.840	0.231	3.63	0.000
DEPAMORT	–	−0.407	0.978	−0.42	0.339
WCACC	–	−1.801	0.493	−3.65	0.000
RDACC	+	5.442	2.754	1.98	0.025
BV^{cap}	+	1.630	0.148	10.98	0.000
$OTHER^{cap,LIM3}$	?	0.178	0.052	3.41	0.001
Const.		0.172	0.172	1.49	0.069

Table 7 (*Continued*)

Panel C: Vuong likelihood ratio test (LIM 3)		
Model selection	Vuong's Z-statistic	p-Value
LIM_3 (expensing) vs. LIM_3 (capitalizing)	−1.81	0.035

Table 7 presents regression results for LIM_3 (p-values are one-tailed if sign predicted, two-tailed otherwise). Panel A displays results for the expensing sample and Panel B for the capitalizing sample. Differences between the samples in the values of the variables are denoted by the corresponding superscripts. Panel C shows the Vuong's Z-statistic (one-tailed) for significant differences between the results in Panel A versus Panel B. All variables are deflated by total assets at the beginning of fiscal year and winsorized at the top 1% level. The dependent variable is *MV* for market value of equity. The independent variables comprise *OCF* for operating cash flow, *DEPAMORT* for depreciation and amortization, *WCACC* for working capital accruals ($= \Delta \textit{accounts receivable} + \Delta \textit{inventory} - \Delta \textit{accounts payable}$), *RDACC* for R&D accruals ($\textit{RDAMORT} - \textit{RDINV}$), and *BV* for book value of equity. *OTHER* is the estimation of 'other information' in the LIM_3 model: $\textit{OTHER} = MV_{t-1} - \textit{fitted}(MV_{t-1})$, with $\textit{fitted}(MV_{t-1})$ as the fitted value of MV_{t-1} based on LIM_3 excluding 'other information'

hypothesis 3: the R&D accrual component that is derived from capitalizing R&D contains incremental explanatory power for market values and is value relevant. In untabulated findings we further decompose *RDACC* into its components R&D capitalization (*RDINV*) and R&D amortization (*RDAMORT*). While the coefficient for *RDINV* with a value of 5.354 is positive and significant at 0.05, the one for *RDAMORT* is not significant. This is consistent with *DEPAMORT* also not adding incremental information to the regression: While *LTACC* in LIM_2 consisting of investments and *DEPAMORT* showed significant regression coefficients, in LIM_3 *DEPAMORT* by itself does not add explanatory power to the regression ($p = 0.499$ for the expensing sample and 0.399 for the capitalizing sample). This indicates that amortization is not a value relevant component of earnings, while the corresponding investments are. This is consistent with theory, where the main role of depreciation and amortization in valuation results from its role as a predictor of investments in replacement (Schultze 2005).

As previously stated, across all LIMs, the coefficients for *OTHER* are significantly smaller for the capitalizing sample compared to the expensing sample, indicating that R&D capitalization captures some fraction of 'other information'. By capitalizing R&D, 'other information' is integrated into the accounting. Panel A of Table 8 provides a summary of the regression coefficients for *OTHER* from the previous tables. We conduct a Wald test to show that the differences in the weight of *OTHER* are also statistically significant between the two samples. For all LIMs the reported p-values are below 0.05 suggesting that the capitalization of R&D significantly decreases the weight of 'other information'. In other words, parts of 'other information' can be explained by the R&D accrual component that derives when capitalizing such expenditures. This can also be inferred from the *level* of 'other information' under both accounting schemes. *OTHER* can take both positive and negative values depending on whether the actual market value of equity exceeds the fitted value of market value based on LIM_3 without 'other information' or not. In order to make meaningful comparisons across the samples of the level of *OTHER*, we calculate the absolute value of

Table 8 R&D capitalization and the impact on 'other information'

Panel A: Relative weight of 'other information' (OTHER)

$n = 419$	Regression coefficient		Wald test	
	Exp	*Cap*	Chi^2	p-Value
LIM_1	0.216	0.183	3.93	0.047
LIM_2	0.248	0.205	4.17	0.041
LIM_3	0.255	0.178	6.17	0.013

Panel B: Level of 'other information' (OTHER)

$n = 419$	Mean value of absolute values		t-Test	
	Exp	*Cap*	t-Statistic	p-Value
LIM_1	0.730	0.698	3.020	0.001
LIM_2	0.685	0.679	0.625	0.266
LIM_3	0.701	0.619	4.429	0.000

Table 8 presents results on the impact on 'other information' by capitalizing R&D. Panel A shows a summary of the regression coefficients for the variable *OTHER* across all LIMs for both the expensing sample (exp) and the capitalizing sample (cap). A Wald test has been conducted to show significant differences between the regression coefficients for $OTHER^{exp}$ versus $OTHER^{cap}$. Panel B presents the level of *OTHER* based on the mean value of absolute values for the variable. A t-test has been conducted to show significant differences between the mean values for the expensing versus the capitalizing sample

OTHER for each firm-year. Panel B depicts their means per sample. In all three LIMs the mean of the absolute values of *OTHER* for the capitalizing sample is smaller than for the expensing sample, however significant only for LIM_1 and LIM_3. Taken together with the above, this can be interpreted as verification that the accrual component generated when capitalizing R&D captures a significant fraction of information included in market values, otherwise not captured by the accounting system.

The overall results confirm that the R&D accrual component is the source for higher explanatory power of aggregate and disaggregated earnings when R&D expenditures are capitalized instead of immediately expensed. In addition, the capitalization of R&D decreases both the weight and the level of 'other information' and makes more accurate pricing of market value possible.

6 Conclusion

The objective of this paper is to explain the source of the additional explanatory power of earnings when R&D is capitalized compared to an expensing regime. This is controversial because market values capture all publicly available information and it is not clear why accounting as a source of information would be beneficial over other sources of information like, say, an analyst conference. To answer this question, we make use of the general benefits of accrual accounting documented in prior research (e.g. Dechow 1994). Accrual information displays better predictive abilities than cash information. We argue that by capitalizing R&D, accrual information is generated which is more informative than the cash information associated with expensed R&D. Our study therefore hypothesizes that capitalizing R&D is value relevant due to the accrual component that is derived from R&D capitalization.

Both our theoretical approach and our empirical investigation using multiple regressions are consistent with this prediction. Firstly, by disaggregating earnings into cash flows and its major accrual components, we demonstrate higher market value explanatory power of disaggregated earnings, consistent with Barth et al. (2005). Further we base our analysis on existing models by Dechow (1994), extending it by different aspects such as considering non-current accruals, introducing R&D accruals as specific long-term accruals obtained through the capitalization of R&D expenditures, and including book values and 'other information' according to the Ohlson (1995) model. We use data from a sample of large, R&D intensive German firms to form an expensing sample and a capitalizing sample. The capitalizing sample provides earnings that better explain market values than the expensing sample due to the additional accrual component. We document the benefits of accrual accounting as shown by Dechow (1994) in the context of intangibles, R&D in particular. Her findings suggest that accruals contribute notably to an improved reflection of earnings for firm performance. Our extension of her model and empirical results allow us to extend her findings, which predominantly are referred to working capital accruals, by concluding that R&D accruals are value relevant.

We aim at explaining the increased explanatory power documented in many prior studies that arises when R&D is capitalized. Especially in all studies using adjusted accounting data (e.g. Lev and Sougiannis 1996), the market has not received the information via accounting but from other sources. Their results therefore do not allow to directly conclude that R&D capitalization is more informative. The information included in market values is already available to the market as 'other information' through other channels than accounting. Our results establish that R&D capitalization captures this other publicly available information and internalizes it into the accounting. We document a substitution of 'other information' by the R&D accrual created in the capitalization process. At the same time, the explanatory power of the full data set, including both 'other information' and the R&D accrual increases. This indicates that internalizing the information in accrual accounting is more useful in explaining market values than leaving the information in 'other information'. Based on the findings of the accrual literature, this is due to the benefits of accruals over cash flows, that is, the better predictive power of accruals over cash flows.

We acknowledge several limitations of our study: due to the relatively small sample size we are unable to further analyze industry specific differences. Yet, all firms in our sample are highly R&D intensive providing an ideal setting for our research question. Further, both in practice and theory, R&D capitalization has been considered a tool for earnings management (e.g. Markarian et al. 2008) or as a signaling device (e.g. Ahmed and Falk 2006). Our research design does not allow for any managerial discretion, leaving such aspects unanswered. However, only by abstracting from such influences, we can tease out the sources responsible for the accrual benefits of R&D capitalization. In turn, our research design is not intended to answer questions regarding the actual R&D accounting of our sample firms. To the contrary, differences between the firms are washed out by our comparing of the two samples. Only the differences in R&D accounting based on our adjustments remain. Results based on actual data would thus likely be different, depending on whether the accrual, signaling, or distorting effects from earnings management prevail. In addition, our research design does not allow differentiating more or less successful R&D projects. More research is necessary to distinguish between these aspects of R&D capitalization.

Our study opens several avenues for future research. The results presented here suggest that R&D accruals obtained by creating a capitalizing sample are value relevant. Future research can investigate why and how investors value the additional earnings component. Further we recommend an application of our methodology to observable data with actual partial R&D capitalization. A comparison of adjusted and observable data might add new insights into the economic consequences of the accounting for R&D.

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Appendix: Classification of the literature on R&D and intangibles according to capital market relevance

Author(s)	Sample	Results	Classification
Aboody and Lev (1998)	1987–1995 Compustat	Capitalized software development costs are positively associated with stock returns and the cumulative software asset reported on the balance sheet is associated with stock prices. Capitalization change is associated with subsequent earnings changes. Software capitalization does not reduce earnings quality.	Value relevance
Abrahams and Sidhu (1998)	1994–1995 Australian Stock Exchange	R&D capitalization assists in improving the usefulness of accounting based performance measures; stepwise removal of accruals leads to performance measures that are statistically inferior to net profits after tax; largest shift in explanatory power when the accrual R&D capitalization is removed.	Value relevance
Ahmed and Falk (2006)	1992–1999 Australian Stock Exchange	Allowing managers to credibly signal their superior information by either capitalizing successful R&D investment or expensing unsuccessful R&D investments reduces information asymmetry and increases value relevance. They suppose that IAS 38 might have a negative impact on benefits of discretionary R&D capitalization.	Value relevance
Ahmed and Falk (2009)	1988–2000 Australian Stock Exchange	Expensed R&D expenditures generate higher risk in future earnings than current capital expenditures. Both expensed R&D expenditures and capital expenditures generate higher risk in future earnings than discretionary capitalized R&D expenditures.	Value relevance (Reliability)
Amir et al. (2007)	1972–2002 Compustat	R&D contributes to variability of subsequent operating income more than physical assets => only in R&D intensive industries. There are fundamental differences between investment information about R&D and CAPEX. Support for R&D capitalization in certain circumstances (according to IFRS).	Value relevance (Reliability)
Amir and Lev 1996	1984–1993 Compustat	Non-financial information is value relevant in the wireless communication industry (more contributable to prices than earnings, book values, cash flows): complementarity between financial and non-financial data. Investors rely primarily on non-financial information: undo GAAP procedures, which is quite costly as the reports do not provide sufficient information.	Value relevance (non-financial information)

Author(s)	Sample	Results	Classification
Amir et al. (2003)	1977–2000 Compustat	Analysts' reports partly compensate for shortages of reported financial information. Especially in firms with high intangibles intensity, analysts contribute incrementally over financial reports. Over the last 20 years, analysts also seem to increasingly 'get intangibles'.	Analysts' forecasts
Barron et al. (2002)	1986–1998 Compustat	Usefulness of current earnings for predicting future earnings varies with the degree to which a firm is comprised of intangibles. Expensed intangibles are associated with more analyst uncertainty. Benefit of aggregating individual analysts' forecasts is higher for high-intangible firms.	Analysts' forecasts
Barth et al. (2001c)	1983–1994 Compustat	Positive association between intangibles and analyst coverage.	Analysts' forecasts
Bryant (2003)	1994–1996 Oil and Gas Firms	Full cost > successful efforts > full expense – consistent with accrual accounting being more value-relevant than a cash-basis accounting – due to earnings smoothing. Policy of full capitalization of expenditures with uncertain future economic benefits > partial capitalization.	Value relevance
Cazavan-Jeny and Jeanjean (2006)	1993–2002 French listed firms	Negative association between capitalization and stock return as a different result from prior research: France has a low legal enforcement => managers have a more opportunistic approach to the use of R&D capitalization. Firms that capitalize are smaller, highly leveraged, less profitable, and have less growth opportunities.	Value relevance
Chambers et al. (2003)	1986–2000 Compustat	Simulation of different scenarios of R&D capitalization with various degrees of managerial discretion. The usefulness of accounting information only substantially increases if preparers are given high discretion.	Value relevance
Daley and Vigeland (1983)	1972 Compustat and Moody's	Accounting choice to capitalize or to expense R&D before 1974 in the US is affected by the existence of debt covenants, interest coverage, and ability to pay dividends. Capitalizers are more highly levered, use more public debt, are closer to dividend restrictions, and are smaller than expensers.	Event study (Determinants)
Goodwin and Ahmed (2006)	1975–1999 Australian Stock Exchange	Australian answer to Lev and Zarowin (1999): Value relevance of earnings and book value has increased for capitalizers. No significant improvement for non-capitalizers; capitalizers that amortize generally have the highest earnings value relevance.	Value relevance

Author(s)	Sample	Results	Classification
Green et al. (1996)	1990–1992 UK listed firms	UK market values R&D expenditures and treats them as if they were capital expenditures. In the case of R&D, UK market does not appear to be only fixated on earnings.	Value relevance
Gu and Wang (2005)	1981–1998 Compustat	Positive association between analysts' forecast error and firms' intangible intensity. Forecast errors are greater for firms with diverse/innovative technologies.	Analysts' forecasts
Hand (2003)	1980–2000 Compustat	1. Net present value (NPV) of expenditures on R&D have been consistently positive. 2. Profitability of R&D increased more than threefold. 3. NPV profitability of R&D increases as the scale of the expenditures made on those intangibles increases. 4. Increasing profitability returns-to-scale of expenditures on R&D have become more pronounced over time.	Value relevance
Healy et al. (2002)	Simulated R&D data for pharmaceutical industry	Trade-off between relevance and reliability; simple capitalization rule (e.g. successful-efforts method) shows higher value relevance than immediate R&D expensing or full cost R&D capitalization. Successful-efforts method even dominates in the presence of earnings management.	Value relevance (Reliability)
Ho et al. (2007)	1990–1999 Compustat	Reported values for expensed R&D affect analysts' forecast revisions following quarterly earnings announcements. Analysts' forecast revisions and R&D expenses are positively correlated suggesting higher analysts' scrutiny in the presence of high R&D intensity.	Analysts' forecasts
Kothari et al. (2002)	1972–1997 Compustat	R&D investments generate future benefits that are far more uncertain than benefits from PPE investments due to higher earnings volatility: no support of either expensing or capitalizing.	Value relevance (Reliability)
Lev et al. (2005)	1983–2000 Compustat	Increased association of adjusted earnings and book value with current stock price and future pre R&D earnings (=intrinsic value) and future returns.	Value relevance
Lev et al. (2005)	1972–2003 Compustat	Key drivers of reporting biases: R&D growth, return on equity, earnings growth; systematic evidence of mispricing: high R&D growth firms: report conservatively low R&D growth firms: report aggressively.	Value relevance
Lev and Sougiannis (1996)	1976–1991 NYSE, AMEX, OTC	Capitalization and amortization of R&D is value relevant by adjusting earnings and book values.	Value relevance

Author(s)	Sample	Results	Classification
Lev and Sougiannis (1999)	1972–1989 CRSP, Compustat	R&D capital is significantly associated with subsequent returns. R&D intensive firms: R&D capital subsumes B/M effect; association between R&D capital and subsequent returns due to a risk factor associated with R&D rather than mispricing.	Value relevance
Lev and Zarowin (1999)	1977–1996 Compustat	Linkage: intangibles—business change—loss of value relevance of financial information. Two proposals: capitalization of intangibles, restated financial reports.	Value relevance
Markarian et al. (2008)	2001–2003 Milan Stock Exchange	R&D capitalization according to IFRS increases managerial income smoothing.	Value relevance
Matolcsy and Wyatt (2006)	1990–1997 Barclays Australasia Consensus Earnings Profile	Capitalization of intangibles is associated with higher analyst following and lower absolute earnings forecast errors: evidence for benefits for analysts when managers have the option to capitalize intangibles. IAS 38 (AASB 138) reduces the usefulness of financial statements.	Analysts' forecasts
Mohd (2005)	1986–1995 NYSE, AMEX	After the introduction of SFAS 86 in the US information asymmetry decreased. Capitalization of software development costs seems to decrease the uncertainty of investors for future benefits.	Value relevance
Oswald (2008)	1996–2004 UK listed firms	The decision to expense or capitalize R&D is influenced by a number of determinants. Managers choose the correct accounting method for R&D in order to best communicate the private information they hold.	Value relevance (Determinants)
Oswald and Zarowin (2007)	1990–1999 UK listed firms	Capitalization of R&D is associated with higher future earnings response coefficients than expensing.	Value relevance
Ritter and Wells (2006)	1979–1997 Australian Stock Exchange	Positive association between stock prices and voluntarily recognized and disclosed identifiable intangible assets; positive association between identifiable intangible assets and realized future period income. AASB 138 is more restrictive; recognition of identified intangible assets will diminish while disclosure of identified intangible assets is value relevant.	Value relevance
Shi (2002)	1990–1993 Compustat	Capitalizing software developments costs (SFAS 86) leads to higher earnings variability which is positively correlated with forecast errors.	Analysts' forecasts

Author(s)	Sample	Results	Classification
Shi (2003)	1991–1994 Compustat, Moody's	The positive impact of R&D on firm value may be driven by the expected value but it may also be due to higher riskiness. Hence, capitalizing R&D as an asset is not always compelling.	Value relevance (Reliability)
Sougiannis (1994)	1975–1985 Compustat	Long-run impact of R&D on market value consists of an indirect and direct effect: R&D variables are valued conditional on earnings. Different from prior research: R&D tax shields are found to be valued as earnings.	Value relevance
Tutticci et al. (2007)	1992–2002 Australian Stock Exchange	Based on returns models, higher audit quality increases the reliability of capitalized R&D; based on price models, the cumulative R&D asset is less relevant in the period following Australian Securities Commission monitoring.	Value relevance (Reliability)
Woolridge and Snow (1990)	1972–1987	Statistically significant positive abnormal returns on announcements on an increase in R&D.	Event study
Wyatt (2005)	1993–1997 Australian Stock Exchange	Managerial discretion provides benefits for investors and firm: – concern of manipulation is overstated – limiting managers' choice reduces quality of balance sheet information – managerial insights about underlying economic determinants are main driver for reporting choice.	Value relevance (Determinants)
Wyatt (2008)	State-of-the-art	R&D is generally not reliably measured and may be less relevant in some contexts than others as well. Differences in value relevance can be due to different relevance or reliability, or both.	Value relevance
Zantout and Tsetsekos (1994)	1979–1990 Compustat	Effects of R&D announcements and voluntary disclosure of R&D: – positive abnormal return for announcing firm – negative abnormal return for rival firm.	Event study
Zhao (2002)	1990–1999 international comparison	Initial attempt to empirically test the effect of R&D accounting standard in an international context (France, Germany, UK, USA): – R&D reporting increases value relevance – Allocation of R&D costs between capitalizing and expensing provides incremental information – Mixed results of previous comparative earnings studies due to different R&D reporting standards and reporting environment.	Value relevance

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