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Accounting for R&D on the income statement? Evidence on non-discretionary vs. discretionary R&D capitalization under IFRS in Germany

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A B S T R A C T

This paper compares the informativeness of discretionary research and development (R&D) capitalization under IAS 38 with non-discretionary "as-if" R&D capitalization. While prior research consistently demonstrated capital market benefits of "as-if" capitalization, prior evidence for reported R&D capitalization are less favorable due to earnings management concerns. Because "as-if" studies are based on adjusted data assuming R&D capitalization, the resulting numbers are free from such concerns and may be more informative. We find that reported capitalized R&D is not associated with lower information asymmetry but positively associated with forecast errors. While market values are not associated with reported capitalized R&D, they are strongly associated with "as-if" capitalized R&D. Also, actual capitalization of development expenditures under IAS 38 is only as value relevant as when expensing all R&D. Our results are consistent with the notion that market participants undo actual capitalization and use the information on expensed R&D to develop their own estimates of R&D value. Our findings lend support to the proposition by Barker and Penman (2020) that deficiencies of the balance sheet that result from the uncertainty inherent in expenditures such as R&D, should be supplemented by more detailed information on the nature of the related expenses in the income statement.

1. Introduction

The accounting for intangibles such as research and development (R&D) remains an unresolved question and a major discrepancy between International Financial Reporting Standards (IFRS) and US Generally Accepted Accounting Principles (GAAP) (Lev, 2019). We use the German setting with highly R&D-intensive firms applying IFRS[1] to compare the informativeness of discretionary R&D capitalization under IAS (International Accounting Standard) 38[2] with non-discretionary "as-if" R&D

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[1] The German setting is particularly interesting because R&D spending in absolute terms ranks number 4 worldwide after the US, Japan, and China. R&D intensity is equivalent to the US (2.9 percent) (2019). However, of those countries only Germany has adopted IFRS.

[2] IAS 38 requires partial capitalization of development expenditures if and only if the criteria under IAS 38.57 are met (e.g., technical feasibility, ability to use or sell the asset etc.), similar to SFAS (Statement of Financial Accounting Standard) 86 under US GAAP. Note that while all research expenditures need to be immediately expensed under IFRS, a portion of development expenditures may still also be expensed. Previously incurred development expenditures also remain expensed. The recognition criteria require the firm to demonstrate technical and commercial feasibility. Applying these criteria gives managers discretion in whether or not to meet the criteria. While these regulations allow for a capitalization of development expenditures only, we refer to "R&D capitalization" for brevity.

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capitalization derived from additional disclosed information. Whereas prior research has consistently demonstrated capital market benefits of "as-if" capitalization (e.g., Lev & Sougiannis, 1996), such benefits are questionable for reported capitalized R&D under IFRS due to earnings management concerns (e.g., Dinh et al., 2016; Jones, 2011; Mazzi et al., 2019). However, actual and "as-if" capitalization have not yet been compared within the same setting. Because "as-if" studies are based on adjusted data where the actual accounting for R&D is undone and capitalization is assumed, the resulting numbers are free from earnings management and may hence be more informative.

Whereas standard setters and researchers have mainly discussed the potential usefulness of presenting capitalized intangible assets on the balance sheet (Garanina et al., 2021), Barker and Penman (2020) propose that more emphasis be given to the income statement. Penman (2009) argues that "there is also an income statement" and that market participants can use this information to make up for potentially "deficient" balance sheets. Barker and Penman (2020) add that under uncertainty, a perfect matching of expenses and revenues is impossible, which makes balance sheets necessarily deficient for cases where mismatching is inevitable such as R&D. R&D expenditures cannot be reliably matched to future economic benefits that may or may not derive from them due to their uncertain nature. They conclude that uncertainty provides a role for the income statement in presenting relevant information to supplement the incomplete information in the balance sheet. Hence, they propose that additional information on "mismatched expenses", such as expensed intangibles, be given in a separate section of the income statement in order to signal that such expenses represent investments rather than used-up resources or amortization. Because disclosures on expensed R&D are already presented in quite some detail under IFRS,[3] the accounting for R&D provides an ideal setting for testing the proposal in Barker and Penman (2020) that information on the income statement can make up for the deficiencies of incomplete balance sheets. Our results offer insights on how such additional information helps investors in valuing uncertain intangibles.

Whereas under US GAAP R&D costs have to be expensed immediately, IAS 38 requires partial capitalization for development (but not research) expenditures if certain criteria are met. The International Accounting Standards Committee (IASC)'s decision (IAS 38 BCZ 39c) was based on empirical studies in the US.[4] In these studies (Chambers et al., 2003; Healy et al., 2002; Lev & Sougiannis, 1996), the US full R&D expensing regime was reversed to reflect "as-if" R&D capitalization, *assuming* full (or partial) capitalization of R&D expenditures. The results suggest "as-if" capitalization enhances explanatory power for market values and the resulting "as-if" R&D asset is value relevant. Since "as-if" capitalization is based on information on expensed R&D, this approach corresponds to Barker and Penman's (2020) proposal to use the information on the income statement to make up for deficiencies of the balance sheet.

While studies based on "as-if" capitalization generally find benefits of R&D capitalization, studies using *reported* R&D capitalization have found less favorable evidence. In some settings of national GAAP, studies find higher value relevance (e.g., Ahmed & Falk, 2006; Chen et al., 2017; Smith et al., 2001), while others find lower value relevance related to earnings management concerns (Cazavan-Jeny & Jeanjean, 2006; Cazavan-Jeny et al., 2011; Landry & Callimaci, 2003; Markarian et al., 2008). The overall evidence suggests that the decision to capitalize is largely driven by managerial opportunism (e.g., Jones, 2011; Jeny & Moldovan, 2021). For IFRS, Dinh et al. (2016) find that capitalized R&D is value relevant only for firms that are not suspect of earnings management. Consistently, survey evidence documents that investors in many markets are wary of R&D capitalization and prefer expensing due to potential earnings management (e.g., Entwhistle, 1999; Haller et al., 2008).

Based on this skepticism of market participants toward R&D capitalization, textbooks on financial statement analysis (e.g., Robinson, 2020; White et al., 2003) suggest undoing actual capitalization, adding back expensed R&D to earnings, and evaluating R&D expenditures separately to derive one's own estimate of the value of the R&D ventures. This is consistent with the approach taken in "as-if" studies and the view expressed in Barker and Penman (2020). If evaluating R&D expenditures separately is beneficial, "as-if" R&D accounting should be more informative than the actual accounting for R&D under IFRS.

The main difference between studies of reported and "as-if" capitalization is that for the latter, researchers use information outside the balance sheet to develop their own estimates of R&D assets rather than using the reported capitalized amounts. "As-if" capitalized amounts, therefore, do not involve managerial discretion and are free from earnings management. Due to this lack of managerial discretion, however, their informativeness to market participants cannot be based on signaling theory (Riley, 1975, 2001), as is assumed for studies of reported R&D capitalization. The source for the informativeness of "as-if" numbers may rather derive from the benefits of matching and accrual accounting (Dechow, 1994; Penman & Yehuda, 2009). Therefore, we adopt an accruals perspective.

Accrual accounting is found beneficial because it resolves timing and matching problems (Dechow, 1994). However, accruals suffer from unavoidable estimation errors (Dechow & Dichev, 2002). Particularly R&D is subject to high uncertainty and estimation error (Amir et al., 2007; Kothari et al., 2002). Due to this uncertainty and the discretion involved, capitalizing R&D under IAS 38 may create accruals of low reliability, which is shown to impair market pricing (Richardson et al., 2005). Hence, market participants may not trust discretionary R&D capitalization and rely on non-discretionary "as-if" accruals instead. Based on this, we would expect that actual R&D capitalization is not informative, while "as-if" capitalization is.

[3] Among other things, IFRS requires that firms "disclose the aggregate amount of research and development expenditure recognised as an expense during the period" (IAS 38.126).

[4] IAS 38 BCZ 39c states: "certain research studies, particularly in the United States, have established a cost-value association for research and development expenditures. The studies establish that capitalisation of research and development expenditure yields value relevant information to investors."

We test this expectation using a German sample of R&D intensive firms applying IFRS. We adjust the firms' accounts and create two samples of "as if" data, in addition to the original dataset, where we assume (1) full R&D expensing or (2) full R&D capitalization. We do so by undoing the discretionary R&D accounting following prior "as-if" studies. We receive two additional samples of identical size, consisting of identical firms. The actual data differs from the "as-if" data in the treatment of R&D only, allowing for direct comparisons across samples and inferences. We disaggregate earnings into operating cash flows and accrual components based on the accrual literature (Dechow, 1994) in order to determine R&D accruals as the net effect of capitalized and amortized development expenditures.

We begin by examining the informativeness of actual R&D capitalization under IAS 38 using a triangular approach based on information asymmetry, analysts' forecasts, and market pricing. We find no evidence of a reduction in information asymmetry as suggested by signaling theory, contrary to Mohd (2005) for software development. Next, we find that capitalized R&D under IAS 38 is associated with significantly higher forecast errors, consistent with the additional complexity in estimating future earnings when capitalized R&D is involved (Aboody & Lev, 1998; Dinh et al., 2015). Also, we find that the market does not price discretionary reported R&D accruals, consistent with the notion that market participants relate earnings management with actual R&D capitalization under IAS 38.

Based on this finding that the average R&D capitalization under IFRS is not useful for investors, we compare reported to "as-if" capitalized R&D. We aim to investigate whether market participants use procedures of evaluating R&D ventures based on expensed R&D, independent from actual capitalization. We find that the explanatory power for market values of reported capitalized R&D does not exceed that of fully *expensed* R&D, consistent with the interpretation that market participants undo the original capitalization. To the contrary, we find that non-discretionary "as-if" R&D accruals are significantly positively associated with market values. These findings indicate that market values are more consistent with market participants pricing the overall amount of R&D expenditures as an asset than reported capitalized R&D.

Next, we examine possible explanations for these findings. Consistent with Barker and Penman (2020) and the textbooks' recommendation of evaluating R&D expenditures separately, it is likely that market participants apply such procedures. If so, we would expect that analysts' forecasts of future earnings are strongly associated with earnings before R&D and total R&D expenditures. We find evidence consistent with this expectation. Moreover, we find that analysts' forecasts are associated with expensed R&D, but not with capitalized R&D. Consistently, the latter is not associated with future economic benefits, while R&D expenditures strongly are. Overall, these findings imply that market participants are skeptical of reported capitalized R&D, undo the latter and value R&D expenditures separately as assets.

Our results are robust to various sensitivity checks. We apply the Heckman (1979) procedure to control for self-selection due to voluntary IFRS adoption. In addition, we apply a two-stage least squares (2SLS) approach to control for endogeneity related to the capitalization of development expenditures where appropriate (Larcker & Rusticus, 2010; Lennox et al., 2012). We also use a variety of different deflators. The results remain qualitatively unchanged.

Our findings contribute to the literature on intangibles. While prior research has unequivocally demonstrated benefits of "as-if" R&D capitalization, the benefits of reported R&D capitalization are less clear. To resolve this contradiction, our study is the first to compare reported to "as-if" capitalized R&D. This analysis is important given that IAS 38 is built on evidence largely based on "as-if" capitalization. Our results indicate that R&D expensing can present information that is more useful than capitalized R&D when making use of the information on expensed R&D. This is consistent with the proposal by Barker and Penman (2020) that deficiencies of the balance sheet be supplemented by more detailed information on the nature of the related expenses in the income statement. Market participants can use this information to develop their own estimates of the value of R&D. Our findings show that such a procedure is feasible, and the resulting information is useful for market participants. This approach of providing more detailed information on "mismatched expenses" may hence be used for other intangibles, as suggested (but not tested) by Barker and Penman (2020).

In particular, we find that the "as-if" information is more useful than current R&D accounting under IFRS. Whereas IFRS requires judgment for capitalization decisions and, thus, permits earnings management, market participants' own evaluations are free from such concerns. To avoid discretion, Lev (2019) argues for a full capitalization of R&D expenditures at their inception. However, while this proposal avoids earnings management concerns at the inception, later impairments are still subject to earnings management, as was shown for the equivalent case of goodwill (e.g., Ramanna & Watts, 2012).

This paper is organized as follows. Section 2 reviews relevant prior literature and develops the hypotheses. Section 3 describes our methodology. Section 4 describes our sample and presents descriptive statistics. Section 5 presents the main empirical findings, including additional analyses and robustness checks. Section 6 concludes the paper.

2. Related literature and hypotheses development

The accounting for intangibles was studied extensively and is considered by some as a main deficiency of modern accounting (e.g., Lev, 2019). The relevance of the issue is said to have increased over the last decades. Similar to Dichev and Tang (2008), Lev (2018, 2019) finds that matching has deteriorated since the mid-60s. Firms' growing R&D activities paired with immediate expensing are considered a main reason for increasingly poor matching, which results in decreasing usefulness of accounting information (Lev & Zarowin, 1999). The question of capitalizing R&D was studied in great detail over the last 30 years in a variety of settings. This research can be divided into three groups: 1) US studies based on "as-if" capitalized R&D, 2) international studies based on reported capitalized R&D under national GAAP and 3) international studies based on IAS 38 information.

The first group relates to US studies from the mid-90s until early-00s (e.g., Chambers et al., 2003; Healy et al., 2002; Lev & Sougiannis, 1996). These studies mimic R&D capitalization by creating "as-if" capitalized R&D. More specifically, they assume full (or partial) capitalization of R&D expenditures and adjust the accounting information including capitalized R&D on the balance sheet, book value of equity and earnings. This approach allows to study the effects of an accounting treatment that differs from the SFAS 2 rule of immediately expensing all R&D expenditures. These studies show that "as-if" capitalized R&D is value relevant. The IASC's decision to prescribe capitalization of development expenditures in IAS 38 is based on these results on the benefits of (theoretical) R&D capitalization.

The second stream of research is based on reported capitalized R&D under different national accounting regimes. In these settings, R&D capitalization is directly observable because national GAAP allow for such an accounting treatment. Studies of reported capitalized R&D draw on signaling theory (Riley, 1975, 2001) and argue that capitalization represents a signal of management's private information on the future success of R&D ventures (e.g., Ahmed & Falk, 2006; Oswald & Zarowin, 2007). If capitalization of R&D serves as a credible signal, the resulting accounting information can be deemed informative. Particularly under Australian GAAP, where the capitalization of R&D is highly discretionary, these signals were found to be informative (e.g., Abrahams & Sidhu, 1998; Ahmed & Falk, 2006; Smith et al., 2001). For UK firms, Oswald (2008) shows that both expensers and capitalizers make the "correct" capitalization choice in order to provide the best private information to the market. Zhao (2002) compares four different accounting regimes and confirms that R&D accounting affects the explanatory power of accounting information for market values. In countries where R&D has to be expensed immediately (Germany and US), information on total R&D increases the value relevance of book values and earnings. In countries where capitalization of R&D is allowed (France and UK), the allocation to capitalized and expensed amounts increases the value relevance of book values and earnings.

In other national settings, however, discretionary R&D capitalization was shown to be used as a tool for managing earnings, resulting in lower value relevance (e.g., Mande et al., 2000 for Japan; Cazavan-Jeny & Jeanjean, 2006; Cazavan-Jeny et al., 2011 for France; Markarian et al., 2008 for Italy). The discretion inherent in R&D capitalization may be used to meet debt covenants or to smooth income (Landry & Callimaci, 2003 for Canada) and is used for benchmark beating where the resulting accounting does not truthfully reflect future firm performance (Cazavan-Jeny et al., 2011 for France). Moreover, survey evidence indicates that analysts in various settings prefer expensing over capitalizing (e.g., Goodacre, 1991 for the UK; Entwhistle, 1999 for Canada; Haller et al., 2008, for Germany).

The third and more recent set of research investigates R&D capitalization under IFRS. These studies differ from the second stream of research in two main respects: First, compared to the much more discretionary capitalization under e.g., Australian, Canadian, or French GAAP, the rules in IAS 38 are more stringent. Second, studies based on IFRS do not suffer from differences across accounting regulations. However, national differences in the institutional setting, culture, as well as the nature of the underlying R&D still exist that may give rise to different outcomes.

These studies on capitalized R&D under IFRS provide mixed evidence. Jones (2011) finds that the capitalization of intangible assets is primarily driven by managerial opportunism, particularly in firms that are faced with failure. Dinh et al. (2015) find that capitalized R&D is associated with higher analysts' forecast errors due to the high uncertainty involved in estimating future economic benefits and potential impairments. Dinh et al. (2016) show that capitalized R&D under IFRS is informative only when firms are not suspect of earnings management. Similarly, Mazzi et al. (2019) find that firms in countries where corruption is high are more likely to capitalize R&D under IFRS while the association between the capitalized amount and future economic benefits is weaker.

Gong and Wang (2016) provide contradictive evidence for the effects of IFRS adoption on the value relevance of R&D expenses across adopting countries. They expect that for countries that transition from a mandatory expensing or voluntary capitalization regime to IFRS, the value relevance of expensed R&D should decrease, because valuable R&D is capitalized under IFRS and only less relevant R&D expenses should remain. However, when controlling for institutional differences across countries, they find confirmatory evidence only for countries transitioning to IFRS from optional capitalization in a changes specification, but the opposite in their levels regressions.

Kress et al. (2020) show a negative association of capitalized R&D under IFRS with cost of debt. In a sample of select Israeli high-technology firms that apply either IFRS or US-GAAP, Chen et al. (2017) analyze the relevance of voluntary R&D disclosures under IFRS. They find that when they include voluntary disclosure in their value relevance regressions, these disclosures are highly significant, but R&D assets under IFRS are value relevant only for firms with high levels of disclosure. This suggests that the value relevance of capitalized R&D derives from disclosure rather than capitalization itself. Their high-tech sample only includes firms of specific industries such as pharmaceutics, biotechnology, computer electronics, software, and telecommunications. In a more generic German sample, Dinh et al. (2020) demonstrate that capitalized R&D under IFRS is not value relevant by itself, but becomes relevant in the presence of additional disclosed information on R&D in the management commentary. Firms with higher levels of R&D disclosure show higher market values when they capitalize less R&D. These results suggest that R&D disclosure acts as a substitute for capitalization. While they do not investigate the channel through which the additional disclosed information is used by market participants, their findings are consistent with the interpretation that investors use disclosed information on R&D to derive their own estimates. Our study extends these results by explicitly analyzing quantitative disclosures on R&D expenditures to develop measures of "as-if" capitalization.

Studies based on "as-if" capitalized R&D and studies based on reported capitalized R&D are inherently different in the level of managerial discretion, which may explain the contradictory findings. When all R&D is assumed to be capitalized, the level of discretion is zero. For the same reason, Lev (2019) advocates a full capitalization of R&D from the inception and not when certain criteria are met, as under IAS 38. Such full R&D capitalization is non-discretionary and can be considered more objective. In contrast, in the studies on actual R&D capitalization under national GAAP and IFRS discussed above, the decision to capitalize R&D is discretionary and driven by various determinants. Accordingly, Jeny and Moldovan (2021) conclude that the determinants of R&D capitalization across the papers covered in their meta-analysis suggest an opportunistic motivation for the capitalization decision.

In this paper, we contrast reported with "as-if" capitalized R&D as a means to address the problem of managerial opportunism involved in actual capitalization. "As-if" capitalized R&D is derived from disclosed information outside the balance sheet. Consistent with Barker and Penman (2020), we test whether analysts can make up for deficiencies in the balance sheet by their own and independent evaluation of information provided on expensed R&D.

We begin by analyzing the informativeness of actual R&D capitalization under IFRS. We follow a triangular approach and examine the effect on information asymmetry, analysts' forecasts and market values. Based on prior literature, the informativeness of actual R&D capitalization derives from the premises of signaling theory. Discretionary capitalized R&D is considered a signal of managers' private information on the prospect of R&D investments that reduce information asymmetries, and hence increase market valuation (e.g., Ahmed & Falk, 2006; Oswald & Zarowin, 2007).

First, we analyze the association of reported capitalized R&D with information asymmetry, which is not yet tested in the literature. We follow Mohd (2005), who finds lower information asymmetries when software development costs under US GAAP are capitalized. The recognition criteria under SFAS 86 are very similar to those in IAS 38.57. Hence, results for IAS 38 may also be similar to those for SFAS 86, namely that reported capitalized R&D is negatively associated with information asymmetries. Based on signaling theory, we hypothesize:

H1: *Capitalized development expenditures under IAS 38 are negatively associated with information asymmetry.*

However, for R&D capitalization to have such positive capital market consequences, the signal from capitalized R&D needs to be credible. R&D being inherently uncertain, the prospects of R&D projects are difficult to estimate. Due to this difficulty, management may use the discretion in IAS 38 for earnings management rather than signaling (Cazavan-Jeny et al., 2011; Dinh et al., 2016; Landry & Callimaci, 2003; Markarian et al., 2008). Therefore, R&D capitalization may not be a credible signal of future economic benefits. Moreover, Mohd (2005) highlights that the FASB has allowed capitalizing software development costs because, different from other R&D, managers can reliably measure future payoffs from software development projects. Due to the higher level of uncertainty of R&D and the additional noise contributed to the information environment, accounting information under IAS 38 may not be associated with decreasing information asymmetry.

Next, we examine the value relevance of reported capitalized R&D. If R&D capitalization is a credible signal of managers' private information and reduces information asymmetries, this should also lead to higher market values due to a reduction in uncertainty and hence lower discount rates. Thus, based on signaling theory, one would expect capitalized R&D under IFRS to be positively associated with market values. For an Indian sample, Kumari and Mishra (2020) show that disaggregated earnings that include an accrual and a cash flow component, are more value relevant than aggregated earnings. They further find that the association is more important for firms with high intangible intensity. Hence, we analyze R&D accruals as the net effect of capitalized R&D and amortized R&D. We hypothesize:

H2: *R&D accruals as reported under IAS 38 are positively associated with market values.*

However, if the signals from R&D capitalization are not credible due to earnings management concerns, discretionary R&D accruals under IAS 38 may not be priced because accruals naturally are biased due to errors in estimation (Dechow & Dichev, 2002). Because R&D capitalization is associated with high uncertainty (Amir et al., 2007; Kothari et al., 2002), R&D accruals will be subject to increased estimation error and low reliability, which impairs market valuation (Dey & Lim, 2015; Richardson et al., 2005). Hence, reported R&D accruals under IFRS may not be priced by the market, i.e., not be significantly associated with market values.

If we find no association of discretionary R&D capitalization with information asymmetries and market pricing, this evidence would not support signaling theory. To provide more affirmative evidence for the alternative hypothesis that reported R&D capitalization is not informative, we examine analysts' forecast errors. We can expect a positive association with forecast errors because actual R&D capitalization complicates the forecasting process. Forecasting earnings with capitalized R&D involves forecasts of possible write-offs and amortization of previously recognized development costs as well as additional future (ex-ante unknown) capitalization. Hence, the complexity of making earnings forecasts substantially increases for firms that capitalize R&D (Aboody & Lev, 1998; Dinh et al., 2015). Thus, we expect that capitalized R&D impedes the forecasting process and leads to higher forecast errors. We hypothesize:

H3: *Capitalized development expenditures under IAS 38 are positively associated with analysts' forecast errors.*

H3 serves as a confirmatory test of our underlying assumptions that the informativeness of IAS 38 is impaired. Based on this, we continue to analyze the value relevance of "as-if" capitalized R&D. Consistent with Lev's (2019) call to capitalize intangibles from their inception, we analyze full R&D capitalization. Contrary to reported R&D information, "as-if" R&D accruals resulting from "as-if" full R&D capitalization are free from discretion and hence earnings management concerns. Market participants are able to derive their own "as-if" accruals from the information provided outside the balance sheet, consistent with Barker and Penman's (2020) proposal to use the information from the income statement to make up for a deficient balance sheet. Bratten et al. (2013) also show that capital market participants value disclosed information similarly to recognized items, when the disclosed information is easily accessible and equally reliable. Therefore, we expect that the benefits of matching prevail and that non-discretionary "as-if" R&D accruals are value relevant. We hypothesize:

H4: *In an IFRS setting, "as-if" R&D accruals are significantly positively associated with market values when assuming a full capitalization of R&D expenditures.*

If R&D reporting under IFRS was informative, we should not find a positive association with "as-if" capitalized R&D. IAS 38 separates R&D that is more likely to succeed by capitalizing this portion and leaving the more uncertain portion as expensed R&D. If this process was informative, the separate recognition of the more promising portion of R&D on the balance sheet should be more informative than the naïve "as-if" capitalization of all R&D.

3. Research methodology

3.1. Information asymmetry

For H1 we follow Mohd (2005) to analyze capitalized R&D under IAS 38 and information asymmetries proxied by bid-ask spreads (*SPREAD*).

$$SPREAD_{it} = \beta_0 + \beta_1 dummy\_cap_{it} + \beta_2 Log\_MV_{it} + \beta_3 FOL_{it} + \beta_4 TURNOVER_{it} + \beta_5 SHARE\_VOL_{it} + \beta_6 PRICE_{it} + \beta_7 DAX30_{it} + \beta_8 IMR_{it} + YEAR + IND + \varepsilon \quad (1)$$

If not stated otherwise, all regressions include year and industry fixed effects, and standard errors are clustered by firm and year (Petersen, 2009). Consistent with Mohd (2005), *SPREAD* is the annual average of the natural logarithm of the daily relative bid-ask spread, defined as the absolute value of the bid-ask spread divided by the average of bid and ask. Our main variable of interest in (1) is the indicator variable *dummy_cap*, which equals 1 if a firm capitalizes R&D in a certain year and 0 otherwise.

While Mohd (2005) only analyzes the impact of *dummy_cap* on information asymmetry, we rerun (1) and replace *dummy_cap* by the capitalization ratio *CAP_RATIO* (capitalized R&D divided by total R&D). This allows differentiating between firms with a large portion of capitalized development expenditures versus smaller portions. In addition, we replace *dummy_cap* by *RDCAP*[5], which is the amount of development expenditures capitalized scaled by lagged total assets. A negative coefficient of *dummy_cap* (and *CAP_RATIO* and *RDCAP*, respectively) would be consistent with signaling theory and Mohd (2005).

Mohd (2005) controls for stock exchange listing because in the US NASDAQ firms show higher bid-ask spreads compared to NYSE/AMEX firms. In Germany, the information environment for DAX30 firms is very different from the information environment for non-DAX30 firms with the latter showing higher bid-ask spreads.[6] Therefore, we include the dummy variable *DAX30* in our model. Except for *IMR* (=inverse Mill's Ratio), which will be explained in section 3.4, all remaining control variables are consistent with Mohd (2005). All variables are defined in the appendix.

3.2. Market pricing of reported R&D accruals

For our analysis on market pricing, we follow a standard value relevance approach and use a simplified Ohlson (1995) model. We disaggregate earnings (*E*) into operating cash flow (*OCF*) and total accrual components (*TACC*), based on the accrual literature (Dechow, 1994) in order to separate the R&D accruals (*RDACC*). *RDACC* captures the net effect of R&D capitalization and amortization (*RDACC* = *RDAMORT* − *RDCAP*). In order to analyze its effect on market values, *OCF* and *TACC* need to be adjusted by the capitalization and amortization effect, respectively: *OCF_AS_IF_EXP* = *OCF* − *RDCAP* and *TACC_AS_IF_EXP* = *TACC* − *RDAMORT*. We test the market pricing of R&D accruals by the following model:

$$MV_{it+3months} = \beta_0 + \beta_1 BV_{it-1} + \beta_2 OCF\_AS\_IF\_EXP_{it} + \beta_3 TACC\_AS\_IF\_EXP_{it} + \beta_4 RDACC_{it} + \beta_5 CONTROLS_{it} + YEAR + IND + \varepsilon \quad (2)$$

We negatively code *RDACC* to make interpretations more intuitive, because investments are negatively defined. $\beta_4 > 0$ would be consistent with the notion that an increase in R&D capitalization (R&D amortization) increases (decreases) market values and provide support for H2.[7] However, as outlined above, possible alternative circumstances like high uncertainty of R&D investments and related investor skepticism may result in β_4 not being significant.

[5] Note that although the variable is named "*RDCAP*", it only includes the amount of capitalized development expenditures as IAS 38 prohibits any capitalization of research expenditures.

[6] See Booth et al. (1999) for a direct comparison between NASDAQ and DAX30 companies traded on IBIS regarding bid-ask spreads. They find that on average, there is no difference in bid-ask spreads between the two. However, when focusing on the ten most heavily traded stocks in each market, spreads are lower for DAX30 firms.

[7] This only applies when the amount of R&D capitalized is higher than the amount of R&D amortized which is both intuitive and readily observable.

3.3. Forecast accuracy and market pricing of "as-if" R&D accruals

We corroborate our previous tests by analyzing the impact of capitalized R&D on forecast errors. We run the following regression:

$$FE_{it} = \beta_0 + \beta_1 dummy\_cap_{it} + \beta_2 Log\_MV_{it} + \beta_3 FOL_{it} + \beta_4 LOSS\_BEFORE\_CAP_{it} + \beta_5 EVAR\_BEFORE\_CAP_{it} + \beta_6 RD\_INTENSITY_{it} + \beta_7 IMR_{it} + YEAR + IND + \varepsilon \quad (3)$$

FE_{it}, is the natural logarithm of the absolute consensus analyst forecast error. All variables are defined in the appendix. Note that we adjust *LOSS* and *EVAR* to reflect accounting information excluding the effect of capitalized R&D indicated by the suffix *_BEFORE_CAP*.

As in regression (1), our main variable of interest is *dummy_cap*, which we also replace by *CAP_RATIO* and *RDCAP*. Consistent with prior research (Aboody & Lev, 1998; Dinh et al., 2015), we expect the regression coefficient β_1 to be significantly positive due to the increasing complexity in the forecasting process when capitalized R&D is involved.

Finally, we analyze "as-if" capitalized R&D. Consistent with textbooks on financial statement analysis, we expect investors to undo actual capitalization, add back expensed R&D to earnings and to evaluate R&D expenditures separately. This is in line with previous "as-if" studies that assume full capitalization of all R&D and with Lev (2019) advocating to capitalize intangibles from inception. We follow prior "as-if" studies and adjust the R&D-related financial data. More specifically, we follow Healy et al. (2002) who assume a "full-cost method" in the pharmaceutical industry and capitalize all R&D expenditures from Phase I clinical trials onwards. Chambers et al. (2003) call it the "no-discretion R&D accounting policy" where they capitalize all R&D expenditures. Different to Chambers et al. (2003, p. 88) we do not apply a "one-size fits all amortization" with the same amortization period for all sample firms but we apply amortization rates of 15–25 percent depending on firm industry. Mead (2007) provides a literature review of the amortization rates used in all prior R&D capital and industry-level R&D studies. He finds that amortization rates range from 12 to 29%. For consistency, we presume the lowest rate (15%) for firms that belong to the chemicals industry, the highest rate (25%) for firms that manufacture scientific instruments such as electronic equipment, and an intermediate rate (20%) for the remaining firms (e.g., Lev et al., 2005).

The adjusted data set includes *RDACC_AS_IF_CAP* which equals the net effect of R&D expenditures as reported (*RD_TOTAL*) and an adjusted amortization for previously capitalized R&D. We also make these adjustments to book value of equity, cash flow from operating activities and total accruals. Fig. 1 provides an overview of the three identical data sets based on actual data, adjusted full expensing, and adjusted full capitalization.

Consistent with H4, we expect a positive regression coefficient of "as-if" R&D accruals based on full capitalization of R&D (*RDACC_AS_IF_CAP*) in our market pricing model:

$$MV_{it+3months} = \beta_0 + \beta_1 BV\_AS\_IF\_CAP_{it-1} + \beta_2 OCF\_AS\_IF\_EXP_{it} + \beta_3 TACC\_AS\_IF\_EXP_{it} + \beta_4 RDACC\_AS\_IF\_CAP_{it} + \beta_5 CONTROLS_{it} + YEAR + IND + \varepsilon \quad (4a)$$

Note that the only difference between regression (2) and regression (4a) is the discretion involved in capitalizing only a portion of development expenditures under IAS 38 as opposed to capitalizing all R&D. We further rerun regression (4a) and include the dummy variable *dummy_cap* and the interaction term *dummy_cap*RDACC_AS_IF_CAP* to allow for variation between expensers and capitalizers.

$$MV_{it+3months} = \beta_0 + \beta_1 BV\_AS\_IF\_CAP_{it-1} + \beta_2 OCF\_AS\_IF\_EXP_{it} + \beta_3 TACC\_AS\_IF\_EXP_{it} + \beta_4 RDACC\_AS\_IF\_CAP_{it} + \beta_5 dummy\_cap_{it} + \beta_6 dummy\_cap_{it} * RDACC\_AS\_IF\_CAP_{it} + CONTROLS_{it} + YEAR + IND + \varepsilon \quad (4b)$$

If β_6 is significant, we can infer different pricing of "as-if" R&D accruals of expensers versus capitalizers. Otherwise, the market treats R&D as assets independent from the accounting.

3.4. Self-selection bias from voluntary IFRS adoption

To reduce potential biases from self-selection associated with voluntary IFRS adoption, we use Heckman's (1979) inverse Mill's Ratio (e.g., Leuz & Verrecchia, 2000; Cazavan-Jeny et al., 2011). Various factors are shown to be associated with the voluntary choice to adopt IFRS like firm size, foreign stock exchange listing, auditor size etc. (e.g., Dumontier & Raffournier, 1998; Leuz & Verrecchia, 2000). As our sample includes voluntary IFRS-adopters pre-2005, we need to incorporate these factors. We run the following logit regression[8]:

$$VOL\_IFRS_{it} = \beta_0 + \beta_1 US\_UK\_LIST_{it} + \beta_2 CAPITAL\_INT_{it} + \beta_3 BIG5_{it} + \beta_4 LEV_{it} + \beta_5 ROA_{it} + \beta_6 Log\_MV_{it} + YEAR + IND + \varepsilon \quad (5)$$

[8] Untabulated results show a significantly positive association of auditor size (*BIG5*), leverage (*LEV*), and profitability (*ROA*) with a firm's decision to voluntarily adopt IFRS (*VOL_IFRS*) consistent with previous research (e.g., Dumontier & Raffournier, 1998; Leuz & Verrecchia, 2000). However, we find no significant results for stock exchange listings in the UK and/or the US (*US_UK_LIST*), capital intensity (*CAPITAL_INT*), and firm size (*Log_MV*).

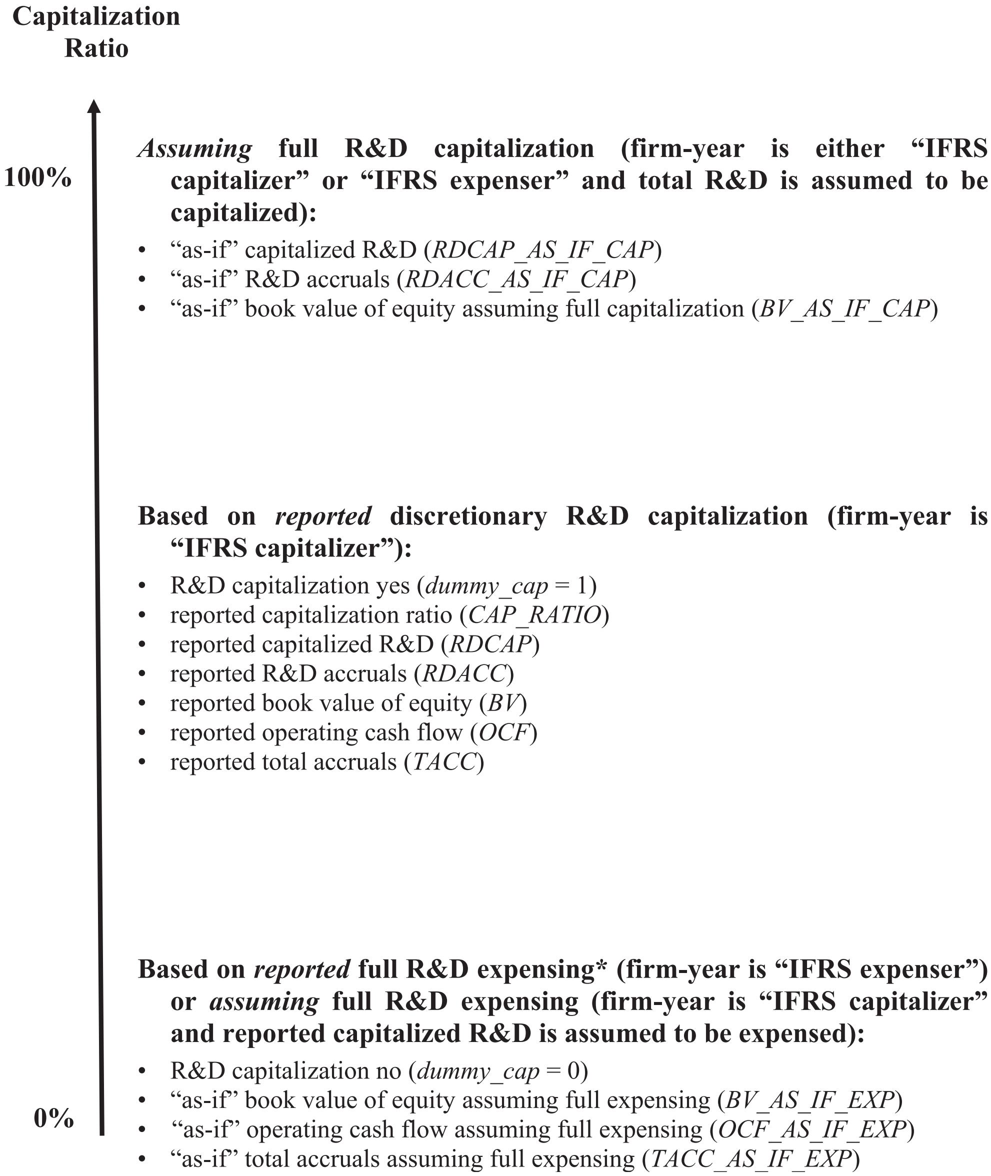

Fig. 1. Overview regarding actual (as *reported*) and "as-if" (*assuming* full R&D capitalization or full R&D expensing) accounting information. * Note that if firm-year is IFRS expenser: *BV_AS_IF_EXP = BV*. Variable definitions in appendix.

Based on regression (5), we calculate the inverse Mill's ratio (*IMR*) as the ratio of the probability density function and the cumulative distribution function of a standard normal distribution. *IMR* considers the various factors that may drive the choice to adopt IFRS and is included as an independent variable in all our main regressions.

3.5. Endogeneity

The decision to capitalize (*dummy_cap*) and how much is capitalized (*CAP_RATIO* and *RDCAP*) is likely endogenous, which may bias ordinary least squares (OLS) results (e.g., Mohd, 2005 for software development; Oswald, 2008 for R&D). Note that this problem of endogeneity is different from the self-selection bias outlined previously. Only companies that apply IFRS can actually capitalize development expenditures under IAS 38. Hence, we first calculate the IMR to address the potential self-selection bias related to voluntary IFRS adoption in our sample. In a second step, we also need to factor in the determinants that drive the de-facto choice to capitalize development expenditures under IFRS. We address this endogeneity concern by instrumenting *dummy_cap*, *CAP_RATIO*, *RDCAP*, and applying a 2SLS approach.

This requires a set of instrumental variables to eliminate the correlation between decisions to capitalize R&D and the error term. Prior literature on the problem of endogeneity when internally generated intangible assets are capitalized, suggests that the capitalization of R&D under IAS 38 may depend on the following factors (e.g., Cazavan-Jeny & Jeanjean, 2006; Dinh et al., 2016; Mohd, 2005; Markarian et al., 2008; Oswald, 2008):

$$dummy\_cap_{it} = \beta_0 + \beta_1 LEV\_BEFORE\_CAP_{it} + \beta_2 ROA\_BEFORE\_CAP_{it} + \beta_3 RD\_INTENSITY_{it} + \beta_4 Log\_MV_{it} + \beta_5 LAG\_CAP_{it} + \beta_6 CAP\_YEARS_{it} + \beta_7 EVAR\_BEFORE\_CAP_{it} + \beta_8 IMR_{it} + YEAR + IND + \varepsilon \quad (6)$$

See the appendix for variable definitions. These instruments must satisfy two conditions. First, they should be correlated with *dummy_cap* (*CAP_RATIO* or *RDCAP*, respectively), i.e., instrument relevance. Second, they need to be uncorrelated with the error term, i.e., instrument exogeneity (Stock & Watson, 2019). The capitalization ratio of the previous year (*LAG_CAP*) is the main instrument as it satisfies these criteria. Regression (6) is the first stage in a 2SLS regression including *dummy_cap* (alternatively *CAP_RATIO* or *RDCAP*) as an independent variable.[9]

The increasing use of instrumental variable regressions in accounting research has raised concerns and the demand for a more diligent use of 2SLS approaches (Larcker & Rusticus, 2010). We provide detailed information on the validity of the instruments, test for weak identification, potential under- and/or overidentification, and only apply 2SLS if the test of endogeneity is significant. In robustness tests we rerun our analyses based on OLS.

4. Sample and descriptive statistics

We use the 168 firms that are included in the four main German stock market indexes DAX, MDAX, TecDAX, and SDAX in Germany as of 2007, over the sample period 2001–2008. The firms belong to the Prime Standard and fulfill both the transparency requirements of the harmonized European capital market and additional international transparency requirements. The 168 firms make up 80 percent of the trading volume and market capitalization of the Prime Standard and 73 percent of the entire regulated market. We obtain market data from Thomson Datastream database and Bloomberg. Forecast information was retrieved from I/B/E/S. Data on R&D was collected manually from individual companies' annual reports as the specific R&D information is not publicly available in data bases.

Table 1 displays our sample selection. We start with 1,344 observations. We first remove 240 observations from the financial services sector due to their specific regulatory environment. Further, we focus on IFRS companies only.[10]

We remove all remaining German GAAP (106) and US GAAP (179) observations. Next, we remove 280 observations with no R&D expenditures in the specific year. IAS 38.126 requires companies to disclose the aggregate amount of R&D expenditures. We also remove 51 observations where the disclosures on the expensed amount are missing, i.e., where a capitalization ratio of 1 would result.

Finally, after excluding observations with missing accounting or market information required by our models, our final sample consists of 413 firm-years. Thereof 206 observations (57 firms) show capitalized R&D>0 ("IFRS capitalizers") and 207 observations (56 firms) fully expense all R&D ("IFRS expensers").

Table 2 Panel A presents descriptive statistics separately for the 206 firm-years of IFRS capitalizers and for the 207 firm-years of IFRS expensers. We winsorize continuous variables at the 1st and 99th percentile. In our sample, R&D expenditures play a significant role with a mean of *RD_INTENSITY* of 0.05 (0.04) for IFRS capitalizers (IFRS expensers); the difference is significant at the 0.10 level (t-statistic in last column: -1.63, $p < 0.10$).

The portion of R&D expenditures that are capitalized as an asset, average around 0.20 (median of *CAP_RATIO* = 0.14). Compared to previous research on R&D capitalization, German firms seem to moderately capitalize R&D. Capitalization ratios are reported to be on average 0.62 for the UK (Oswald, 2008), 0.04 for Australia (Abrahams & Sidhu, 1998), and 0.09 for Italy (Markarian et al., 2008) for various sample periods. In our setting, IFRS capitalizers on average capitalize over a period of about three years (mean of *CAP_YEARS* = 2.84 years; median = 3 years).[11]

With regards to market information (*SHARE_VOL*, *MV*, and *FOL*), the values are significantly larger for IFRS capitalizers compared to IFRS expensers. For market value, *MV* is significantly larger for IFRS capitalizers, but only at the upper end of the distribution (t-statistic for total distribution -2.70, $p < 0.01$). However, median *MV* for IFRS capitalizers is smaller than for IFRS expensers (EUR 1.33 billion versus EUR 1.65 billion).

The market-to-book ratio (*MB*) is significantly higher for expensers than for capitalizers. This is consistent with high-growth firms spending more on pure research expenditures that must be expensed immediately. We further find significant differences for *ROA*, *LEV*, and *BETA*, but not for *LOSS* and *EVAR*.

[9] Note that as in the pricing regression, for variables affected by the capitalization (and subsequent amortization/impairment) of R&D, we make adjustments to the data and remove all capitalization effects. For example, return on assets (*ROA*) includes net income and total assets that will be different if a firm capitalizes R&D or not. Without such an adjustment it is hard to argue that *ROA* can actually impact *dummy_cap* (*CAP_RATIO* or *RDCAP*) at all. Therefore, we include adjusted amounts of *LEV*, *ROA*, and *EVAR* in our first-stage regression and denote the adjustments with the suffix *_BEFORE_CAP*. Exact calculations for the adjustments are outlined in the appendix.

[10] Before IFRS became mandatory in 2005, German firms were allowed to use either US GAAP or IFRS on a voluntary basis. Firms that had previously prepared their accounts according to US GAAP were given two more years after 2005 to switch to IFRS.

[11] Note, that also IFRS expensers have some experience with capitalizing R&D but only over on average of 0.23 years (median = 0.00). This is due to 20 firms that capitalize in some years and expense in other years.

Table 1
Sample selection procedure and final sample of IFRS capitalizers and IFRS expensers.

	# years	# firms
Firms included in main German stock market indexes (DAX, MDAX, TecDAX, and SDAX) as of 2007. Sample period is 2001–2008	8	168
total firm-years (8x168)		1,344
# firm-years belonging to the financial services industry		−240
# firm-years under German GAAP		−106
# firm-years under US GAAP		−179
# firm-years with no R&D activities (*RD_TOTAL* = 0)		−280
# firm-years with missing information on expensed R&D (*CAP_RATIO* = 1)		−51
# firm-years with missing observations on the test variables		−75
	final sample (firm-years)	**413**
	number of IFRS capitalizers (57 firms)	206
	number of IFRS expensers (56 firms)	207

Table 2 Panel B reports Pearson and Spearman correlations. Bold correlation coefficients denote statistical significance at the 0.05 level or less (two-tailed). By nature, *RD_TOTAL* is highly positively correlated with *RD_INTENSITY*. Similarly, *CAP_RATIO* and *RDCAP* are highly positively correlated because they only differ in their deflating variable. The same is true for *dummy_cap*. The capitalization ratio of the previous year (*LAG_CAP*) and current capitalization ratio (*CAP_RATIO*) are also highly positively correlated. Likewise, the number of years a firm has capitalized R&D (*CAP_YEARS*) is highly correlated with *dummy_cap* and *CAP_RATIO*. We find a significantly negative Spearman correlation coefficient of *SPREAD* with *CAP_RATIO* which suggests that capitalizing R&D under IFRS is associated with lower information asymmetry (H1). Multiple regression analysis is used to provide further insights into this relationship.

With regards to market pricing, *MV* is not positively correlated with *RDCAP* and *RDACC* (H2) but the correlation coefficient has a negative sign (Pearson correlation −0.066 for *RDCAP*; similarly −0.124 for *CAP_RATIO* and −0.165 for *dummy_cap*). Hence, the univariate analysis suggests a negative association of market values with actual capitalization of R&D under IFRS. To the contrary, we observe a significant and positive correlation of *MV* with *RD_TOTAL* (Pearson correlation 0.265) and the adjusted R&D accruals assuming full capitalization of all R&D (Pearson correlation 0.097 for *RDACC_AS_IF_CAP*). This is consistent with H4. *BV_AS_IF_CAP* shows a high positive correlation above 50% with both *RD_TOTAL* and *RD_INTENSITY* due to the adjustments made based on total R&D. Our univariate analyses do not find evidence consistent with H3, that is, increasing forecast errors. However, all R&D information is significantly positively associated with analyst following (*FOL*). R&D intensive firms seem to be followed by analysts more often.

5. Main results

5.1. Information asymmetry

Table 3 displays the results of our tests on information asymmetry (1). The first column presents OLS estimates with *dummy_cap* as the main independent variable. In the second and third column, *dummy_cap* is replaced by *CAP_RATIO* and *RDCAP*, respectively, to examine the influence of the magnitude of R&D capitalization.

In none of the three models, we find a significantly negative association with *SPREAD* as proposed by signaling theory (H1). Different to capitalized software development expenditures under US GAAP (Mohd, 2005), capitalized R&D under IAS 38 is not associated with lower information asymmetries. To the contrary, the regression coefficient of *dummy_cap* in column 1 is significantly positive (0.035, $p < 0.01$), suggesting that information asymmetries are higher if a firm decides to capitalize R&D. This is consistent with R&D capitalization increasing the uncertainty of the information environment. The results in columns 2 and 3 that are not significant suggest that this does not hold for the magnitude of capitalized R&D.

The overall model shows high statistical validity with an Adjusted R^2 of over 50% (F-test, $p < 0.01$). The regression coefficients of all control variables are consistent with previous literature and most are statistically significant with the expected signs (e.g., Mohd, 2005). Larger firms and firms with high stock prices are associated with lower information asymmetries, as are firms with high analyst following and high share turnover. In all regressions, the Variance Inflation Factor (VIF) takes on values slightly above the conservative threshold of 5 but considerably below the conventional level of 10.[12] We present OLS results in Table 3 as the test on endogeneity is not significant for any of the three specifications.

[12] This is due to the correlation between *DAX30* and *Log_MV* because the composition of Frankfurt DAX30 is based on market capitalization. When excluding *DAX30*, the highest VIF drops down to 3.97 in all three models of Table 3. However, given the highly significant regression coefficient of *DAX30*, we believe it is crucial to include this control variable in the models.

Table 2
Descriptive statistics.

Panel A: Descriptive statistics both for IFRS capitalizers (206 firm-years) and IFRS expensers (207 firm-years)

Variable	Mean	Std Dev	25%	Median	75%	Exp – Cap
RD_INTENSITY	0.05 *(0.04)*	0.07 *(0.05)*	0.02 *(0.01)*	0.03 *(0.02)*	0.06 *(0.05)*	−1.63*
RD_TOTAL	0.59 *(0.23)*	1.25 *(0.58)*	0.03 *(0.01)*	0.06 *(0.03)*	0.37 *(0.09)*	−3.82***
RDCAP	0.11 *(0.00)*	0.29 *(0.00)*	0.00 *(0.00)*	0.01 *(0.00)*	0.04 *(0.00)*	−5.35***
RDAMORT / RDCAP	0.77 *(N/A)*	1.52 *(N/A)*	0.03 *(N/A)*	0.46 *(N/A)*	0.83 *(N/A)*	N/A
CAP_RATIO	0.20 *(0.00)*	0.20 *(0.00)*	0.05 *(0.00)*	0.14 *(0.00)*	0.30 *(0.00)*	−14.54***
CAP_YEARS	2.84 *(0.23)*	1.63 *(0.75)*	2.00 *(0.00)*	3.00 *(0.00)*	4.00 *(0.00)*	−20.85***
SPREAD	0.01 *(0.01)*	0.01 *(0.00)*	(0.00) *(0.00)*	(0.01) *(0.01)*	(0.01) *(0.01)*	−0.56
FE	1.63 *(1.31)*	3.47 *(2.34)*	0.24 *(0.15)*	0.55 *(0.52)*	1.36 *(1.57)*	−1.08
FOL	17.31 *(15.09)*	9.65 *(9.00)*	9.00 *(8.00)*	15.00 *(14.00)*	25.00 *(22.00)*	−2.41**
TURNOVER	0.09 *(0.08)*	0.27 *(0.22)*	(0.00) *(0.00)*	(0.01) *(0.01)*	(0.01) *(0.01)*	−0.33
SHARE_VOL	40.76 *(38.48)*	18.70 *(15.42)*	27.40 *(26.99)*	36.19 *(34.91)*	49.10 *(45.93)*	−1.35*
MV	7.62 *(4.63)*	12.70 *(9.50)*	0.50 *(0.55)*	1.33 *(1.65)*	10.40 (5.08)	−2.70***
BV	5.34 *(2.31)*	8.98 *(4.02)*	0.31 *(0.24)*	0.76 *(0.92)*	5.69 *(2.62)*	−4.43***
E	0.70 *(0.30)*	1.19 *(0.70)*	0.02 *(0.03)*	0.09 *(0.09)*	0.94 *(0.33)*	−3.98***
ROA	0.04 *(0.06)*	0.05 *(0.08)*	(0.02) *(0.02)*	0.04 *(0.06)*	0.06 *(0.09)*	3.28***
LOSS	0.10 *(0.11)*	0.30 *(0.31)*	(0.00) *(0.00)*	(0.00) *(0.00)*	(0.00) *(0.00)*	0.30
LEV	2.60 *(1.98)*	2.92 *(3.52)*	1.36 *(0.89)*	2.06 *(1.41)*	3.05 *(2.07)*	−1.96**
EVAR	0.30 *(0.34)*	1.28 *(1.36)*	0.01 *(0.01)*	0.04 *(0.04)*	0.10 *(0.16)*	0.32
BETA	0.95 *(0.86)*	0.45 *(0.51)*	0.64 *(0.49)*	0.96 *(0.80)*	1.23 *(1.19)*	−1.97**
MB	1.92 *(2.74)*	1.24 (2.55)	1.09 (1.07)	1.63 (2.02)	2.48 (3.52)	4.19***

Panel B: Pearson correlation (Spearman correlation) below (above) the diagonal for the full sample (n=413)

		1	2	3	4	5	6	7	8	9	10	11	12
1	*RD_INTENSITY*		**0.932**	**0.131**	0.054	**0.204**	**0.126**	−0.050	0.075	**0.113**	**0.216**	0.058	0.015
2	*RD_TOTAL*	**0.872**		**0.097**	0.007	**0.168**	**0.170**	−0.077	−0.013	**0.235**	**0.259**	**0.165**	−0.011
3	*dummy_cap*	0.080	0.052		**0.870**	**0.870**	−0.070	0.061	**0.105**	**−0.200**	**−0.204**	**−0.190**	−0.014
4	*CAP_RATIO*	−0.068	**−0.097**	**0.583**		**0.952**	**−0.123**	0.053	**0.142**	**−0.243**	**−0.247**	**−0.215**	−0.010
5	*RDCAP*	0.259	**0.335**	**0.464**	**0.570**		−0.041	0.043	**0.088**	**−0.222**	**−0.207**	**−0.220**	−0.001
6	*SPREAD*	**0.168**	**0.261**	−0.024	−0.093	**0.237**		**−0.085**	**−0.693**	−0.074	**0.182**	**−0.158**	−0.029
7	*FE*	−0.055	**−0.112**	0.073	−0.016	**−0.028**	−0.091		**0.134**	**−0.291**	**−0.176**	**−0.114**	0.058
8	*FOL*	−0.003	−0.039	**0.132**	**0.132**	0.022	**−0.523**	0.084		**−0.084**	**−0.215**	**0.142**	**0.127**
9	*MV*	**0.163**	**0.265**	**−0.165**	**−0.124**	−0.066	0.013	**−0.196**	−0.096		**0.593**	**0.439**	**−0.199**
10	*BV*	**0.393**	**0.396**	−0.089	−0.076	**0.124**	**0.182**	**−0.171**	**−0.168**	**0.545**		**0.146**	**−0.163**
11	*OCF_AS_IF_EXP*	0.006	**0.097**	**−0.227**	**−0.190**	**−0.182**	**−0.102**	**−0.103**	**0.126**	**0.366**	0.016		**0.404**
12	*TACC_AS_IF_EXP*	0.042	0.032	−0.081	−0.075	−0.010	0.050	−0.074	0.075	**−0.151**	**−0.125**	**0.539**	
13	*RDACC*	0.093	**0.216**	**0.346**	**0.511**	**1.000**	**0.209**	−0.073	−0.020	−0.009	**0.125**	**−0.140**	−0.039
14	*BV_AS_IF_CAP*	**0.723**	**0.721**	**−0.110**	**−0.158**	**0.093**	**0.145**	**−0.142**	−0.091	**0.514**	**0.820**	**0.101**	−0.080
15	*RDACC_AS_IF_CAP*	**0.287**	**0.503**	0.049	−0.050	**0.198**	**0.212**	**−0.126**	−0.058	**0.097**	**0.258**	0.046	0.044
16	*LAG_CAP*	−0.047	**−0.097**	**0.461**	**0.751**	**0.405**	**−0.105**	0.020	**0.138**	**−0.109**	−0.064	**−0.203**	−0.090
17	*CAP_YEARS*	0.006	−0.041	**0.721**	**0.549**	**0.365**	−0.048	0.054	**0.147**	**−0.168**	−0.086	**−0.218**	−0.092
18	*IMR*	**0.213**	**0.166**	−0.055	−0.019	0.046	**0.119**	−0.063	−0.086	**0.111**	**0.445**	**−0.174**	0.059

		13	14	15	16	17	18
1	*RD_INTENSITY*	**0.099**	**0.560**	**0.364**	0.023	−0.002	**0.134**
2	*RD_TOTAL*	0.060	**0.609**	**0.433**	−0.030	−0.042	0.069
3	*dummy_cap*	**0.462**	**−0.200**	**0.111**	**0.682**	**0.806**	**−0.115**
4	*CAP_RATIO*	**0.612**	**−0.261**	0.057	**0.785**	**0.748**	**−0.123**
5	*RDCAP*	**0.652**	**−0.171**	**0.127**	**0.749**	**0.729**	**−0.121**
6	*SPREAD*	−0.022	**0.157**	**0.108**	**−0.164**	**−0.087**	0.059
7	*FE*	0.014	**−0.139**	**−0.136**	0.056	0.048	**−0.119**
8	*FOL*	0.044	**−0.105**	**−0.083**	**0.154**	**0.100**	−0.031
9	*MV*	**−0.123**	**0.560**	**0.209**	**−0.261**	**−0.218**	**0.230**
10	*BV*	**−0.142**	**0.839**	**0.307**	**−0.267**	**−0.197**	**0.568**
11	*OCF_AS_IF_EXP*	**−0.182**	**0.180**	**0.149**	**−0.234**	**−0.209**	**−0.083**
12	*TACC_AS_IF_EXP*	−0.069	**−0.125**	−0.035	−0.033	−0.039	0.043
13	*RDACC*		**−0.140**	**0.146**	**0.428**	**0.332**	**−0.142**
14	*BV_AS_IF_CAP*	0.067		**0.225**	**−0.285**	**−0.253**	**0.460**
15	*RDACC_AS_IF_CAP*	**0.235**	**0.154**		0.005	0.052	**0.084**
16	*LAG_CAP*	**0.238**	**−0.147**	−0.035		**0.760**	**−0.137**
17	*CAP_YEARS*	**0.213**	**−0.149**	0.017	**0.570**		**−0.086**
18	*IMR*	0.079	**0.319**	**0.138**	−0.041	−0.058	

Notes:
In Panel A, *RD_TOTAL*, *RDCAP*, *MV*, *BV*, and *E* are all in billion EUR. The last column shows *t*-statistics for two-sample *t*-tests with equal variances for testing significant differences between mean values for expensers versus capitalizers. ***, **, and * denote 0.01, 0.05, and 0.10 significance levels (two-tailed). In Panel B, *RD_TOTAL*, *RDCAP*, *MV*, *BV*, *OCF_AS_IF_EXP*, *TACC_AS_IF_EXP*, *RDACC*, *BV_AS_IF_CAP*, and *RDACC_AS_IF_CAP* are all scaled by lagged total assets. Correlations in bold when statistically significant at the 0.05 level or less (two-tailed). Continuous variables are winsorized at the 1st and 99th percentile. Variable definitions in appendix.

Table 3
Capitalization of development expenditures and information asymmetry (bid-ask spread).

Dependent variable		*SPREAD* OLS Model 1	*SPREAD* OLS Model 2	*SPREAD* OLS Model 3
dummy_cap	–	0.035***		
		(4.43)		
CAP_RATIO	–		−0.001	
			(−0.01)	
RDCAP	–			12.055
				(1.18)
Log_MV	–	−0.096***	−0.096***	−0.093***
		(−4.04)	(−4.10)	(−3.61)
FOL	–	−0.043*	−0.042*	−0.062**
		(−1.89)	(−1.84)	(−2.14)
TURNOVER	–	−0.031**	−0.031**	−0.029**
		(−2.34)	(−2.33)	(−2.39)
SHARE_VOL	+	0.034	0.033	0.015
		(0.59)	(0.56)	(0.32)
PRICE	–	−0.053*	−0.054*	−0.025
		(−1.67)	(−1.80)	(−1.08)
DAX30	–	−0.264***	−0.265***	−0.272***
		(−4.48)	(−4.57)	(−4.85)
IMR	–	0.007	0.006	0.026
		(0.10)	(0.09)	(0.41)
Constant		0.063	0.055	−0.015
		(0.15)	(0.14)	(−0.03)
Durbin Wu Hausman *F*-Statistic		0.054	0.029	2.064
(Test of endogeneity, *p*-value)		(0.816)	(0.866)	(0.152)
Highest VIF		5.31	5.30	5.30
Year fixed effects		Included	Included	Included
Industry fixed effects		Included	Included	Included
Observations		413	413	413
F-Statistic		116.79	111.86	173.39
Adj. *R2*		0.52	0.52	0.55

Notes:
This table reports the estimation results of an OLS regression (*t*-statistics in parentheses) with *SPREAD* as the dependent variable (regression (1)). All variables defined in appendix. Model 2 (Model 3) replaces *dummy_cap* by *CAP_RATIO* (*RDCAP*). Reported *t*-statistics are based on firm and year clustered standard errors (Petersen, 2009). ***, **, and * denote 0.01, 0.05, and 0.10 significance levels (two-tailed). Continuous variables are winsorized at the 1st and 99th percentile.

5.2. Forecast accuracy

Table 4 Panel A displays the 2SLS regression results with consensus forecast errors (*FE*) as the dependent variable. As in Table 3, the three columns reflect the decision to capitalize R&D (*dummy_cap*) vs. the amount of capitalized R&D (*CAP_RATIO, RDCAP*).

Consistent with the results in Table 3, we find that due to higher uncertainty in the information environment related to capitalized R&D and the additional complexity in the forecasting process, capitalized R&D is positively associated with forecast errors (*FE*). Consistent with H3, the regression coefficient of *dummy_cap* is significantly positive in Model 1 of Table 4 Panel A (0.572; $p < 0.05$). Likewise, the regression coefficients of *CAP_RATIO* in Model 2 (1.144; $p < 0.05$) and of *RDCAP* in Model 3 (39.059; $p < 0.10$) are significantly positive. This suggests that both the fact that a firm capitalizes, and the amount of capitalized R&D may impose challenges to forecast accuracy.

Except for *FOL* and *IMR* in Model 1, the regression coefficients of all control variables are significant at the 0.10 level or less. Their sign is also consistent with our expectations and prior literature except for *Log_MV*. We expected a negative association of firm size based on market value with forecast error but observe a significantly positive association. Larger firms tend to provide more complex information which may be detrimental to an accurate forecasting process. Similarly, the amount of information on larger firms in general may be very high such that it becomes harder to retrieve the relevant information for accurate earnings forecasts. Overall, our findings confirm prior evidence by Aboody and Lev (1998) and Dinh et al. (2015) that capitalized R&D under IAS 38 is positively associated with forecast errors.

Table 4 Panel A presents 2SLS results because the test on endogeneity is significant for all three specifications. First stage results and the endogeneity tests are displayed in Panel B (see section 5.4. for further discussion).

5.3. Market pricing

Table 5 presents the results for the pricing models including R&D accounting information depending on the three different scenarios of Fig. 1: column 1 includes reported R&D accruals (*RDACC*), column 2 no R&D accruals because the setting

Table 4
Capitalization of development expenditures and analysts' forecast errors.

Panel A: Second stage regression estimation results of 2SLS.

Dependent variable		FE 2SLS Model 1	FE 2SLS Model 2	FE 2SLS Model 3
dummy_cap	+	0.572**		
		(2.39)		
CAP_RATIO	+		1.144**	
			(1.97)	
RDCAP	+			39.059*
				(1.85)
Log_MV	–	0.195**	0.190**	0.221**
		(2.03)	(1.99)	(2.10)
FOL	–	−0.179	−0.150	−0.205
		(−1.07)	(−0.94)	(−1.13)
LOSS_BEFORE_CAP	+	1.580***	1.605***	1.465***
		(6.71)	(7.08)	(6.30)
EVAR_BEFORE_CAP	+	0.009***	0.009***	0.009***
		(9.58)	(7.87)	(8.28)
RD_INTENSITY	–	−3.917***	−3.371**	−4.623**
		(−2.69)	(−2.45)	(−1.98)
IMR	–	−0.303	−0.382**	−0.331*
		(−1.49)	(−2.01)	(−1.85)
Constant		−2.543	−2.579	−3.130
		(−1.25)	(−1.28)	(−1.42)
Year fixed effects		Included	Included	Included
Industry fixed effects		Included	Included	Included
Observations		413	413	413
F-Statistic		15.63	28.31	6.78
Centered *R2*		0.25	0.24	0.25

Panel B: First-stage model of instrumental variable regression (2SLS)

Dependent variable		*dummy_cap*	*CAP_RATIO*	*RDCAP*
LEV_BEFORE_CAP	+	0.022**	0.003*	0.000
		(2.67)	(2.01)	(-0.38)
ROA_BEFORE_CAP	–	−0.482	−0.047	−0.005
		(−1.07)	(−1.09)	(−0.84)
RD_INTENSITY	–	0.678**	−0.109	0.028
		(2.38)	(-1.50)	(1.20)
Log_MV	–	−0.005	−0.005	−0.001
		(−0.22)	(−0.74)	(−1.42)
LAG_CAP	+	0.172	0.611***	0.016
		(0.84)	(17.18)	(2.86)
CAP_YEARS	+	1.608***	0.170**	0.006***
		(6.87)	(3.14)	(3.58)
EVAR_BEFORE_CAP	+	0.000	0.000	0.000
		(0.50)	(-0.52)	(-1.56)
IMR	+	0.006	0.023	−0.001
		(0.09)	(1.60)	(-1.64)
Constant		0.073	0.115	0.016
		(0.17)	(0.83)	(1.35)
Year fixed effects		Included	Included	Included
Industry fixed effects		Included	Included	Included
Observations		413	413	413
F-Statistic		12.55	10.37	2.92
Centered *R2*		0.59	0.61	0.36
First-stage 2SLS diagnostics				
Durbin Wu Hausman *F*-Statistic		3.22	7.27	9.00
(Test of endogeneity, *p*-value)		(0.074)	(0.007)	(0.003)
Angrist-Pischke *F*-Statistic		30.63	176.95	16.64
(Test of weak identification, *p*-value)		(0.000)	(0.000)	(0.001)
Angrist-Pischke *Chi2*-Statistic		148.28	856.73	80.56
(Test of underidentification, *p*-value)		(0.000)	(0.000)	(0.000)
Sargan's and Basman's *Chi2*		1.51	5.69	5.59
(Test of overidentifying restrictions, *p*-value)		(0.679)	(0.128)	(0.133)

Notes:
This table reports the estimation results of an instrumental variables regression with *dummy_cap* (Model 1), *CAP_RATIO* (Model 2), and *RDCAP* (Model 3) being instrumented based on regression (6) and *FE* as the dependent variable (regression (3)). All variables defined in appendix. Reported *t*- and *z*-statistics are based on firm and year clustered standard errors (Petersen, 2009). The bottom rows report the detailed diagnostics on the first-stage results. ***, **, and * denote 0.01, 0.05, and 0.10 significance levels (two-tailed). Continuous variables are winsorized at the 1st and 99th percentile.

assumes "as-if expensing" and column 3 includes adjusted R&D accruals (*RDACC_AS_IF_CAP*) based on "as-if" full capitalization. In addition, Model 4 extends Model 3 by including the interaction term *dummy_cap*RDACC_AS_IF_CAP* to distinguish IFRS expensers from IFRS capitalizers.

The coefficient for reported R&D accruals (*RDACC*) in Model 1 is positive but not statistically significant (0.418; $p > 0.10$), which is not consistent with H2. Hence, the evidence does not support signaling theory, that argues reported capitalized R&D represent credible signals to market participants. Our finding is consistent with the notion that market participants are wary of actual R&D capitalization and do not price the reported R&D accruals.

Model 2 examines full expensing of all R&D with an Adjusted R^2 just as high as in Model 1 (0.84). Hence, the explanatory power of capitalized R&D under IAS 38 for market values is not significantly different from expensing all R&D. This suggests that market participants do not use the information on actual R&D capitalization but rather undo it.

Model 3 is based on "as-if" full R&D capitalization (H4). The coefficient of the "as-if" R&D accrual *RDACC_AS_IF_CAP* is positive and highly significant (3.370; $p < 0.01$), which supports H4. This result is consistent with prior "as-if" studies in the US but has not been tested before for IFRS.

Taken together, these findings imply that market values are not associated with reported R&D accruals, but with "as-if" R&D accruals. The data in Models 1, 2, and 3 are identical, except for the degree of discretion involved in determining R&D accruals. Hence, discretion plays a detrimental role for the informativeness of capitalized R&D. The evidence indicates that market participants undo actual capitalization and use the information provided on R&D expenditures to develop their own estimates of the value of R&D. This value seems to closely correspond to full capitalization and subsequent amortization of all R&D expenditures, as is underlying the "as-if" R&D accruals. These results are in line with Barker and Penman's (2020) call for using the information on expensed R&D on the income statement rather than presenting them as assets on the balance sheet.

In Model 4, we investigate how these results differ for the two groups of capitalizing and expensing firms. While the regression coefficient of *RDACC_AS_IF_CAP* is significantly positive (coefficient 3.022, $p < 0.01$), the interaction of *RDACC_AS_IF_CAP* with *dummy_cap* is not ($p > 0.10$). This suggests that the market does not differentiate between capitalizers and expensers when pricing their respective R&D.

Hence, for the average firm, treating the total amount of R&D expenditures as an investment seems to be more consistent with market pricing than the actual R&D accounting under IAS 38.[13] The accounting information on capitalized and amortized R&D itself does not seem to matter for market values.[14] We conjecture that consistent with textbooks on financial statement analysis, market participants incorporate total R&D rather than reported capitalized R&D into their estimates.

The overall models have high statistical validity (Adjusted $R^2 > 80\%$, *F*-values > 40). The control variables carry the expected signs. The results suggest that *US_UK_LIST*, high *MB*, *LOSS*, high *BETA*, low *RD_INTENSITY*, and small *SIZE* are value relevant. We present OLS results in Table 5 because the test on endogeneity is not significant for any of the specifications.

5.4. Endogeneity

The test on endogeneity is only significant in our tests on forecast accuracy. Therefore, Table 4 Panel B also presents the results of regression (6) on the determinants of capitalizing R&D under IAS 38. This regression is the first stage regression in a 2SLS regression analysis where either *dummy_cap*, *CAP_RATIO*, or *RDCAP* is instrumented.

The main instruments are *LEV_BEFORE_CAP*, *RD_INTENSITY*, *LAG_CAP*, and *CAP_YEARS*. The size of the positive coefficients suggests that the decision to capitalize *(dummy_cap)* is largely determined by past capitalization decisions (*CAP_YEARS*). Similarly, the capitalized amount is mainly determined by the previous year's amount (*LAG_CAP*).[15]

The bottom section of Table 4 Panel B presents detailed diagnostics on the first-stage results and validates our instruments. The Durbin Wu Hausman *F*-Statistic is significant at the 0.10 level (two-tailed) or below and rejects the null that the variable *dummy_cap*, *CAP_RATIO*, or *RDCAP* can be treated as exogenous (i.e., OLS is not appropriate and 2SLS is preferred). Larcker and Rusticus (2010) call for a thorough analysis on the instruments used. The reported Angrist-Pischke *F*- and Chi^2-Statistic are both large and significant ($p < 0.01$). Consistent with the "rule of thumb" of Staiger and Stock (1997), the Angrist-Pischke *F*-Statistic should be at least 10 to rule out the possibility of weak identification (Baum et al., 2007).[16] Hence, we can reject the null that our equation is weakly identified. Based on the Angrist-Pischke Chi^2, we can also reject that our equation is underidentified ($p < 0.01$). Finally, the test of overidentifying restrictions shows a Sargan's and Basman's Chi^2 of 1.51, 5.69 and 5.59, which are all not significant. Hence, we can reject the null that the instruments are not valid. The robustness section 5.6. provides further information on the use of different variations of instruments.

[13] This finding differs from Healy et al. (2002) who show that discretionary, partial capitalization is superior to full capitalization and argue for a "successful effort" method for R&D capitalization. However, while their approach is based on simulated data, we analyze actual capitalization.

[14] In her review paper on intangible assets, Wyatt (2008, p. 223) states that "conceptually, the R&D expenditures provide relevant information about value creation, but the measure is not a reliable indicator of future rents". Hence, despite the pricing of *RDACC_AS_IF_CAP* by the market, it is still likely that they are not all related to future economic benefits. We try to proxy for future economic benefits by various measures in our additional analyses.

[15] The fairly low *F*-Statistic of 2.92 in Model 3 of Table 4 Panel B is still significant at the 0.10 level.

[16] In this context, Baum et al. (2007, p. 490) refer to the Kleibergen-Paap rk *F*-Statistic on the test of weak identification. However, the latter will result in the same value as the Angrist-Pischke *F*-Statistic in the presence of only one endogenous regressor as is the case in our models.

Table 5
Capitalization of development expenditures and market pricing.

Dependent variable		*MV* OLS Model 1	*MV* OLS Model 2	*MV* OLS Model 3	*MV* OLS Model 4
BV	+	3.059*** (5.86)			
BV_AS_IF_EXP	+		3.022*** (5.82)		
BV_AS_IF_CAP				1.897*** (5.81)	1.961*** (6.25)
OCF_AS_IF_EXP	+	2.896*** (2.64)	2.809** (2.57)	2.599** (2.25)	2.798** (2.48)
TACC_AS_IF_EXP	–	−3.706*** (-4.28)	−3.623*** (-4.22)	−3.776*** (-5.43)	−3.806*** (-5.19)
RDACC	+	0.418 (0.07)			
RDACC_AS_IF_CAP	+			3.370*** (5.85)	3.022*** (3.37)
dummy_cap	?				0.232** (2.56)
*dummy_cap * RDACC_AS_IF_CAP*	?				−0.382 (-0.22)
US_UK_LIST	+	0.178** (2.55)	0.165** (2.28)	0.134 (1.50)	0.171** (1.98)
MB_BEFORE_CAP	+	0.541*** (7.84)	0.540*** (7.78)	0.516*** (7.28)	0.523*** (7.22)
LOSS_BEFORE_CAP	+	0.038 (0.54)	0.043 (0.62)	0.130** (2.06)	0.153** (2.25)
BETA	+	0.124 (1.42)	0.131 (1.52)	0.219* (1.87)	0.200* (1.67)
RD_GROWTH	+	−0.026 (-0.29)	−0.028 (-0.32)	0.040 (0.41)	0.033 (0.34)
RD_INTENSITY	+/–	−1.061* (-1.89)	−0.684 (-1.33)	−5.995*** (-3.41)	−6.545*** (-3.73)
LEV_BEFORE_CAP	+	−0.064 (-1.16)	−0.063 (-1.15)	−0.075 (-1.38)	−0.081 (-1.47)
SIZE	+/–	−0.038 (-1.45)	−0.035 (-1.28)	−0.074** (-2.51)	−0.081*** (-2.74)
IMR	+	−0.233 (-1.29)	−0.250 (-1.33)	0.040 (0.30)	0.048 (0.34)
Constant		−0.171 (-0.28)	−0.271 (-0.43)	0.607 (0.84)	0.811 (1.10)
Durbin Wu Hausman *F*-Statistic (Test of endogeneity, *p*-value)					0.208 (0.649)
Highest VIF		3.20	3.19	3.44	3.50
Year fixed effects		Included	Included	Included	Included
Industry fixed effects		Included	Included	Included	Included
Observations		413	413	413	413
F-Statistic		40.54	42.01	44.79	45.00
Adj. *R*2		0.84	0.84	0.82	0.83

Notes:
This table reports the estimation results of regression (2), (4a) and (4b) using OLS regression estimates with *MV* as the dependent variable. All variables defined in appendix. Reported *t*-statistics are based on firm and year clustered standard errors (Petersen, 2009). ***, **, and * denote 0.01, 0.05, and 0.10 significance levels (two-tailed). Continuous variables are winsorized at the 1st and 99th percentile.

5.5. Additional analyses

In Table 6 we provide additional analyses to corroborate our main results. We run OLS regressions with future earnings as the dependent variable. In Panel A of Table 6, the dependent variable is future earnings (1-year ahead) as forecasted by analysts without the impact of R&D. We investigate whether analysts incorporate accounting information on R&D into their earnings forecasts differently depending on the firm's R&D accounting. For this purpose, we adjust forecasted future earnings by taking out the effects of R&D accounting. We assume that analysts base their forecasts for future earnings on actual current earnings excluding R&D and value the R&D information separately. We calculate *E_BEFORE_RD* = actual earnings + amortized/impaired R&D + expensed R&D. For the R&D information, we include both *RDCAP* and *RDEXP*. The latter is interacted with *dummy_cap* to differentiate the information on expensed R&D between expensers and capitalizers. We run the following regression to analyze which R&D accounting information is associated with forecasted earnings:

$$E\_BEFORE\_RD\_FORECAST_{it} = \beta_0 + \beta_1 E\_BEFORE\_RD_{it} + \beta_2 RDCAP_{it} + \beta_3 RDEXP_{it} + \beta_4 dummy\_cap_{it} + \beta_5 dummy_{cap} * RDEXP_{it} + \beta_6 IMR_{it} + YEAR + IND + \varepsilon \quad (7)$$

In Model 1 of Table 6, the coefficient on *RDCAP* (0.430; $p > 0.10$) is not significant, while it is positive on *RDEXP* (0.721; $p < 0.01$). The interaction term with *dummy_cap* is also not significant. This indicates that analysts' forecasts are largely based on expensed rather than capitalized R&D but analysts do not differentiate between capitalizers and expensers.

The results presented in Model 2 of Table 6 Panel A confirm these findings and are also consistent with our previous results on market pricing. Forecasted future earnings (*E_BEFORE_RD_FORECAST*) are positively associated with *RD_TOTAL* (0.618; $p < 0.01$). The coefficient of the interaction with *dummy_cap* in column 3 is not significant (-0.103; $p < 0.10$) and suggests that this is again independent from the actual accounting.

Overall, our additional analyses suggest that analysts do not incorporate capitalized R&D into their forecasts. Rather, their forecasts are based on total R&D. This implies that analysts undo capitalization related to R&D, add back expensed R&D to earnings, and evaluate total R&D separately (e.g., Robinson, 2020; White et al., 2003).

In the next step, we examine the relation of R&D capitalization with future economic benefits. To do so, we replace the dependent variable *E_BEFORE_RD_FORECAST* in (7) by various proxies for future economic benefits. Panel B of Table 6 shows the results for a regression with future earnings (1-year ahead) as the dependent variable.

$$E\_BEFORE\_RD_{it+1} = \beta_0 + \beta_1 E\_BEFORE\_RD_{it} + \beta_2 RDCAP_{it} + \beta_3 RDEXP_{it} + \beta_4 dummy\_cap_{it} + \beta_5 dummy_{cap} * RDEXP_{it} + \beta_6 IMR_{it} + YEAR + IND + \varepsilon \quad (8)$$

We rerun (8) with future earnings 2-years ahead and with future cash flow from operations (1- and 2-years ahead). The untabulated results remain qualitatively unchanged.

Table 6 Panel B presents the results for (8).[17] In Model 1 we find that *RDCAP* is marginally negatively associated with future earnings (-1.206; $p < 0.10$), contrary to expectations that capitalized R&D is positively related to future economic benefits. However, *RDEXP* is significantly positively associated with future earnings (0.702; $p < 0.10$). Hence, independent from the accounting, expensed R&D is related to higher future economic benefits.

Consistent with our previous findings, the second column of Panel B shows a significantly positive association of total R&D (*RD_TOTAL*) with future economic benefits (0.389, $p < 0.01$). However, when we differentiate between expensers and capitalizers, this positive effect diminishes with a significantly negative regression coefficient for *dummy_cap*RD_TOTAL* (-0.471; $p < 0.05$). An *F*-test signifies that the sum of the regression coefficients for *RD_TOTAL + dummy_cap*RD_TOTAL* is not significantly different from 0 (*F*-statistic 1.98 with $p > 0.10$). Hence, R&D expenditures of capitalizing firms seem to be significantly less related to future economic benefits compared to those of expensing firms. This effect disappears for future economic benefits 2-years ahead while the amount of capitalized R&D itself is still significantly negatively associated with future earnings 2-years ahead ($p < 0.10$, not tabulated). While this is consistent with our main inferences, the results should be considered with caution due to the lower sample size and non-robust standard errors.

5.6. Robustness checks

We perform robustness checks to ensure our empirical results and inferences are not sensitive to our model specifications and choice of instrumental variables. Except for Table 6 Panel B, all reported results are based on robust standard errors clustered by firm and year. Because the number of clusters for our time variable is rather low and may result in biased results, we also use Huber-White robust standard errors. Our results remain qualitatively unchanged.

For our analysis on information asymmetry, we follow Mohd (2005) and use *TURNOVER* as an alternative proxy for information asymmetry and include *SPREAD* as an independent variable in the model. While the two are highly negatively associated as expected, our main results remain the same. This also holds when we calculate *SPREAD* as the natural logarithm of the annual average of the daily relative bid-ask spread. While *dummy_cap* is no longer significant, this does not affect our main findings.

Despite the significant test statistics for endogeneity, we also run the analyses for forecast errors based on OLS. The association of forecast errors with *dummy_cap* is still significantly positive but not with the amount of R&D (*CAP_RATIO* and *RDCAP*). However, based on our detailed first-stage diagnostics, we are confident that 2SLS is superior to OLS.

We further rerun our level-regression on market pricing based on a change specification. We still find a significantly positive regression coefficient for adjusted R&D accruals only (now *change* in *RDACC_AS_IF_CAP*), while the regression coefficient for actual R&D accruals (now *change* in *RDACC*) is still not significant.

The Heckman (1979) procedure and the instrumental variables regressions are critical for the credibility of our empirical results. Hence, we rerun regression (5) on voluntary IFRS adoption using only the significant variables *BIG5*, *LEV*, and *ROA*, and include the newly calculated *IMR* in all our models. Our results remain unaffected. For the regression on forecast errors with *dummy_cap* as the instrumented variable, *CAP_YEARS* appears to be the main instrument while when using *CAP_RATIO* as the instrumented variable, *LAG_CAP* is the main instrument. When we drop *CAP_YEARS* in the first-stage model, the Durbin

[17] Note that due to the smaller sample size, non-robust standard errors are reported.

Table 6
Additional analyses.

Panel A: R&D accounting information and forecasted future earnings (1-year ahead)				
Dependent variable		*E_BEFORE_RD_FORECAST* OLS Model 1	*E_BEFORE_RD_FORECAST* OLS Model 2	*E_BEFORE_RD_FORECAST* OLS Model 3
E_BEFORE_RD	+	0.442***	0.473***	0.445***
		(5.95)	(6.02)	(6.07)
RDCAP	?	0.430		
		(1.02)		
RDEXP	?	0.721***		
		(5.39)		
dummy_cap	?	−0.011		−0.011
		(-1.05)		(-1.12)
*dummy_cap * RDEXP*	?	−0.061		
		(-0.35)		
RD_TOTAL	+		0.618***	0.715***
			(7.29)	(5.43)
dummy_cap × RD_TOTAL	?			−0.103
				(-0.54)
IMR	?	0.015**	0.020***	0.015**
		(2.07)	(2.97)	(2.07)
Constant		−0.024*	−0.018	−0.024*
		(-1.70)	(-1.39)	(-1.70)
Highest VIF		3.11	1.56	3.50
Year fixed effects		Included	Included	Included
Industry fixed effects		Included	Included	Included
Observations		413	413	413
F-Statistic		89.44	89.95	87.25
Adj. *R2*		0.75	0.74	0.75

Panel B: R&D accounting information and future economic benefits				
Dependent variable		*E_BEFORE_RD$_{t+1}$* OLS Model 1	*E_BEFORE_RD$_{t+1}$* OLS Model 2	*E_BEFORE_RD$_{t+1}$* OLS Model 3
E_BEFORE_RD	+	0.843***	0.903***	0.860***
		(14.93)	(16.54)	(15.19)
RDCAP	+	−1.206*		
		(-1.85)		
RDEXP	?	0.702***		
		(4.50)		
dummy_cap	?	0.008		0.005
		(0.67)		(0.40)
*dummy_cap * RDEXP*	?	−0.308		
		(-1.51)		
RD_TOTAL	+		0.389***	0.680***
			(3.34)	(4.34)
dummy_cap x RD_TOTAL	?			−0.471**
				(-2.44)
IMR	?	0.028*	0.035**	0.028*
		(1.84)	(2.31)	(1.82)
Constant		−0.079	−0.051	−0.080
		(-1.33)	(-0.86)	(-1.32)
Highest VIF		2.85	1.59	3.22
Year fixed effects		Included	Included	Included
Industry fixed effects		Included	Included	Included
Observations		334	334	334
F-Statistic		33.03	37.32	34.10
Adj. *R2*		0.63	0.62	0.63

Notes:
This table reports the estimation results of regression (7) and (8) using OLS because the test of endogeneity is not significant. All variables defined in appendix. Reported *t*-statistics in parentheses are based on firm and year clustered standard errors (Petersen, 2009) in Panel A only. In Panel B, non-robust standard errors are reported due to the decrease in sample sizes. ***, **, and * denote 0.01, 0.05, and 0.10 significance levels (two-tailed). Continuous variables are winsorized at the 1st and 99th percentile.

Wu Hausman *F*-statistic for the test of endogeneity becomes non-significant. When we exclude any instrument other than these main instruments, our 2SLS results on forecast errors remain unaffected.

Finally, we use different deflators instead of lagged total assets, such as average total assets, total sales, and book value at the beginning of the fiscal period. For the analysis on forecast errors, 2SLS still appears to be superior to OLS and all first-stage diagnostics remain qualitatively unchanged. We only find a considerable difference when we use total sales as a deflator; in this specification, the regression coefficient of *RDCAP* in the regression of future earnings forecasts becomes significantly positive ($p < 0.10$) as well as the regression coefficient of *RDEXP*. Consistent with our previous findings, *RD_TOTAL* is significantly positive. This difference does not change our main conclusions.

6. Conclusion

This paper compares the informativeness of actual capitalization under IAS 38 with "as-if" capitalization. While prior research consistently demonstrated benefits of "as-if" R&D capitalization, the results of studies that examine reported R&D capitalization are less favorable. Because the IASC's decision to prescribe partial R&D capitalization was largely based on "as-if" studies, our analysis aims at resolving the conflicting evidence between studies of reported capitalized R&D vs. "as-if" capitalized R&D. Prior studies of actual R&D capitalization have found that reduced informativeness may be due to earnings management concerns. "As-if" studies are free from such concerns because they are based on adjusted data assuming R&D capitalization. Hence, the resulting numbers may be more informative.

Whereas prior literature has focused on R&D reporting on the balance sheet, Barker and Penman (2020) argue that such expenditures inevitably lead to mismatching and, hence, deficiencies of the balance sheet due to the uncertain nature of intangibles. They propose that such deficiencies of the balance sheet be supplemented by more detailed information on the nature of the related expenses in the income statement. Market participants can use this information to develop their own estimates of the value of R&D ventures. This approach is consistent with that of "as-if" studies which use the information on expensed R&D to develop estimates of the value of R&D ventures independent from information provided on the balance sheet. Hence, our study provides evidence for testing the proposal in Barker and Penman (2020).

We find that capitalized R&D under IFRS is not associated with lower information asymmetry but positively associated with forecast errors. Consistently, while market values are not associated with actual R&D accruals, they are strongly associated with "as-if" R&D accruals assuming full capitalization. Actual capitalization of development expenditures under IAS 38 is just as value relevant as expensing all R&D. Additional analyses reveal that analysts apply adjustment procedures consistent with full R&D capitalization based on their own analyses of earnings before R&D and R&D expenditures. Analysts only seem to incorporate the expensed amounts of R&D in their forecasts. This is consistent with analysts preferring R&D expensing because they fear that capitalization of R&D may increase forecast errors.

Our study contributes to the ongoing debate about how to account for internally generated intangible assets such as R&D. Our results imply that the discretion contained in IAS 38 is detrimental to the information content of capitalized R&D and that market participants undo the actual accounting to arrive at their own, non-discretionary estimates. This is consistent with Barker and Penman's (2020) proposal of providing more detailed information on expensed intangibles on the income statement rather than capitalizing them. For the case of R&D where information on R&D expenditures is already presented in quite some detail, our findings establish that such a procedure is feasible, and the resulting information is useful for market participants.

Because R&D accounting remains one of the main discrepancies between US GAAP and IFRS, our findings also contribute to the continuing discussion about a convergence of the two standards (Joos & Leung, 2013; Kothari et al., 2010) and the consequences of IFRS adoption. Our findings suggest that reported R&D accruals are not priced and that R&D capitalization under IAS 38 is not more useful than mandatory expensing.

We acknowledge a few limitations of our study. The specific and detailed data on R&D accounting information had to be collected manually from financial statements and naturally constrains sample size. Both the voluntary adoption of IFRS and the de-facto choice to capitalize development expenditures under IAS 38 raise econometric problems regarding self-selection bias and endogeneity. Despite our great attempt to provide full information on the first-stage results and numerous tests on the relevance and validity of the instruments used, it is still possible that our results are biased. Among the Top-4 R&D intensive countries worldwide, Germany is the only one applying IFRS, which naturally explains the importance of our setting. At the same time, we caution against a generalizability of our findings given differences across institutional settings.

We also acknowledge that future earnings and future cash flow from operating activities (1-year and 2-years ahead) are only crude measures for future economic benefits related to R&D expenditures. They may not fully reflect the long-term benefits related to such investments and also capture benefits related to other investments.

In addition, our study does not allow us to make inferences on specific R&D projects because we did not analyze project-specific R&D information. Future research may focus on one industry only and, thus, provide further insights on how the accounting for R&D may be relevant in the presence of detailed information disclosed on various R&D projects or products. More industry-specific analyses should be particularly insightful.

Data availability

Data are available from public sources as outlined in the paper.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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