Advances in Accounting, incorporating Advances in International Accounting xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Advances in Accounting, incorporating Advances in International Accounting

journal homepage: www.elsevier.com/locate/adiac

Changes in the value relevance of research and development expenses after IFRS adoption

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ARTICLE INFO

Available online xxxx

Keywords:
Accounting standards
IFRS
Value relevance
R&D
Institutional factors
Investor protection

ABSTRACT

We investigate whether the nature of differences between national GAAP and IFRS is associated with differential changes in the value relevance of R&D expenses after the adoption of IFRS across countries. Using a difference-in-differences study on a sample of public companies in nine countries that covers pre-IFRS and post-IFRS periods during 1997–2012, we find that the value relevance of R&D expenses declines after IFRS adoption in countries that previously mandated immediate expensing or allowed optional capitalization of R&D costs. On the contrary, there is no change in the value relevance of R&D expenses for countries that switched from the mandatory capitalization rule to IFRS. We also investigate the moderating effects of national institutions on the changes in the value relevance of R&D expenses after IFRS adoption. We find that in countries with stronger investor protection, the changes in the value relevance of R&D expenses are larger. In addition, changes in the value relevance of R&D expenses are smaller for countries whose national culture is characterized by higher uncertainty avoidance. Our findings highlight the importance of both accounting standards and national institutions in explaining the changes in the value relevance of accounting information after IFRS adoption.

1. Introduction

While the majority of the early international accounting studies have documented benefits of the adoption of the International Financial Reporting Standards (IFRS), such as improved transparency and comparability, more recent evidence is mixed (De George, Li, & Shivakumar, 2015; Horton, Serafeim, & Serafeim, 2013). An important confounding factor in research on the effects of IFRS adoption is the nature of differences between IFRS and the preceding national generally accepted accounting principles (GAAP). Prior studies either omit or do not directly measure the nature of these differences (Pope & McLeay, 2011).[3] These studies focus on the overall effect of the adoption of IFRS by examining the changes in the relationship between prices/returns and earnings following the adoption of IFRS. One limitation of these studies is that aggregate earnings numbers embody differences in accounting treatments for many items, making it impossible to attribute the changes in the value relevance of the aggregate earnings number following the adoption of IFRS to a particular accounting standard (DeFond, Hung, & Trezevant, 2007). This study extends prior literature by taking a different approach. We focus on the value relevance of one specific accounting item: research and development (R&D) expenses. Specifically, we examine how the value relevance of R&D expenses changes after a switch in the accounting treatment of R&D to IFRS. By narrowing down on one accounting element, we can directly measure the differences in R&D accounting treatments between national GAAP and IFRS, and attribute the changes in the value relevance of R&D expenses to IFRS adoption.

We focus on R&D expenses for two reasons. First, considerable variations in accounting treatments of R&D expenditures existed among countries before they adopted IFRS. The national GAAP on R&D expenditures in European countries and Australia either required expensing R&D costs (the mandatory expensing rule), allowed capitalization of R&D costs (the optional capitalization rule), or mandated capitalization of R&D costs under certain conditions (the mandatory capitalization rule). In comparison, IFRS requires capitalization of development costs when certain conditions are met while mandates immediate expensing of research costs. Second, R&D expenditures are a significant accounting element with enormous uncertainty in its future economic benefits and thus have been the subject of many studies. Prior studies have

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[3] So far, prior studies count the number of accounting items where national GAAP and IFRS differ in accounting treatments. This measure of the differences between IFRS and national GAAP ignore whether these differences increase or decrease earnings and/or net assets (e.g., Ding, Hope, Jeanjean, Stolowy, 2007; Bae, Tan, & Welker, 2008).

http://dx.doi.org/10.1016/j.adiac.2016.05.002
0882-6110/

documented that R&D expenses reported in different accounting regimes have different levels of relevance and reliability (Healy, Myers, & Howe, 2002; Zhao, 2002). Therefore, it is interesting to examine how changes in the value relevance of R&D expenses after the adoption of IFRS are related to the nature of differences between pre-IFRS national GAAP and IFRS.

A piece of accounting information is defined as value relevant if it has a predicted association with stock value (Barth, Beaver, & Landsman, 2001). Value relevance research assesses how well accounting amounts reflect information used by equity investors, and provides insights into questions of interest to standard setters. Barth et al. (2001) note that accounting information will be relevant to investors in valuing a company only if it is measured reliably enough to be reflected in share prices. We draw upon prior literature on the economic value of R&D expenditures and value relevance of R&D expenses under different accounting treatments (e.g., Healy et al., 2002; Oswald & Zarowin, 2007). Specifically, we develop three hypotheses on how changes in the value relevance of R&D expenses after the IFRS adoption depend on the pre-IFRS R&D accounting regimes: (1) the value relevance of R&D expenses declines following the switch from the mandatory expensing rule to IFRS; (2) the value relevance of R&D expenses declines following the switch from the optional capitalization rule to IFRS; and (3) the value relevance of R&D expenses increases following the switch from the mandatory capitalization rule to IFRS.

To test our hypotheses, we use a difference-in-differences design to examine the value relevance change after IFRS adoption. We employ both the return and price models to examine the association of reported R&D expenses with stock price and returns. We draw samples over the period of 1997 to 2012 from nine countries that mandatorily adopted IFRS in 2005: Australia, Finland, France, Germany, Netherlands, Norway, Sweden, Switzerland, and the UK.[4] The results from return models show that the value relevance of reported R&D expenses declines after the switch from the mandatory expensing rule or the optional capitalization rule to IFRS. On the other hand, the switch from the mandatory capitalization rule to IFRS does not significantly affect the way markets value reported R&D expenses. The results from price models, however, do not show a significant association between equity price and R&D expenses in our sample before and after the adoption of IFRS.

Ball (2006) points out that accounting is shaped by economic, political, and social institutions, which is echoed by De George et al. (2015). An influential report produced by the Institute of Chartered Accountants in England and Wales (ICAEW) (2015) calls for more research on the links between financial reporting standards, surrounding institutions, and capital market effects. Therefore, in the second half of the paper, we rely on new institutional economics (North, 1991) to guide us to explore how national institutional factors moderate the effects of IFRS adoption on the changes in the value relevance of R&D expenses. As an exploratory analysis, we examine three institutional factors as follows: financial reporting culture, investor protection strength, and uncertainty avoidance in national culture. We find that investor protection strength amplifies the changes in the value relevance of R&D expenses whereas uncertainty avoidance reduces the changes in R&D value relevance following the convergence to IFRS. The specific effects depend on the differences between national GAAP and IFRS.

This study makes three contributions to the literature. First, this study contributes to the growing literature on the effects of IFRS adoption on the value relevance of accounting information. Prior studies have compared the value relevance of earnings before and after the adoption of IFRS and produced mixed evidence on whether the value relevance of earnings has improved following the adoption of IFRS (De George et al., 2015). These studies do not attempt to attribute the differences in the value relevance of the aggregate earnings number to a particular accounting standard. We focus on one specific accounting item: R&D expenses. We find that the changes in the value relevance of R&D expenses after IFRS adoption depend on the preceding national GAAP. Second, we contribute to the international accounting literature by showing that national institutional factors such as financial reporting culture, insider trading law enforcement, and uncertainty avoidance in national culture continue to affect the value relevance of R&D expenses after the adoption of IFRS. Third, our paper contributes to the R&D accounting literature by complementing prior international studies that examine the value relevance of R&D expenses under different accounting regimes across selected countries before IFRS adoption (e.g., Zhao, 2002). We investigate the differential effects of IFRS adoption on R&D value relevance with more sample countries and more recent data. In addition, we examine a different set of national institutions moderating the differential effects of IFRS adoption on R&D value relevance given different accounting regimes before IFRS adoption.

2. Institutional background, prior literature, and hypothesis development

According to the most recent *2014 R&D Magazine/Battelle Global R&D Funding Forecast*, the total spending on R&D around the world is $1.6 trillion, which is about 2% of the worldwide GDP (Battelle, 2013). Companies undertake R&D in the expectation that it will generate significant income from new products and processes. A large number of studies have examined how the capital market interprets the information about R&D expenditures disclosed by companies. Since Hirschey and Weygandt (1985), the accounting literature have documented that both the level of R&D expenditures and the change in R&D expenditures are positively associated with future earnings and market value (e.g., Chan, Lakanishok, & Sougiannis, 2001).

2.1. Institutional background on accounting for R&D

Accounting for R&D activities has been a controversial topic for decades (Hirschey & Weygandt, 1985; Lev & Zarowin, 1999). R&D expenditure is an accounting phenomenon that has significant uncertain future benefits. It is practically difficult to reliably quantify the future economic benefits that can be derived from R&D activities. For this reason, countries such as the USA and Germany generally treat R&D expenditures as expenses regardless of the potential value of R&D activities. Outside the USA, accounting standard setting bodies allow various degrees of capitalization of R&D after weighing on the benefits of capitalizing R&D expenditures and the difficulty of drawing causal relationships between R&D expenditures and future benefits. Considerable variations in accounting treatments of R&D activities existed among countries in the pre-IFRS era. For example, in the UK, research costs and development costs are accounted for differently (Accounting Standards Board, 1989). Companies are permitted, but not required, to capitalize development costs as the projects get closer to commercial success whereas research costs should be expensed during the period incurred.[5] Finland, France, the Netherlands, Norway, and Sweden, on the other hand, allow companies to capitalize both research and

[4] We draw a sample of companies from these nine countries because they are all IASB liaison countries that mandatorily adopted IFRS in 2005. As such, we are able to employ a sufficiently long period of data to assess the changes in the value relevance of R&D expenses after the convergence to IFRS. Furthermore, a large number of firms in these countries regularly report R&D activities.

[5] The accounting standard for R&D (SSAP 13) in the UK was revised in 1989. SSAP 13 states that both pure and applied research are insufficiently identifiable with future economic benefits to be assets and should be written off as incurred. Development expenditures should be written off in the year incurred, unless they meet certain well-defined conditions for deferral. If all of those conditions are met, the development expenditures may be capitalized and amortized as long as their recovery is reasonably assured.

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development costs when certain conditions are met.[6] The GAAP in Australia presents yet another example that the capitalization of R&D costs is required when certain conditions are met (Australian Accounting Standards Board, 1987).[7]

The International Accounting Standards Committee (IASC), the predecessor of International Accounting Standards Board (IASB), employs the terms research-phase costs and development-phase costs in accounting for R&D under the International Accounting Standard (IAS) 38 (IASC, 1998). Under IAS 38, a company is required to classify R&D expenditures into research-phase costs and development-phase costs. The standard requires the company to expense all research costs or any costs if it is not possible to determine in which phase costs have been incurred. Development costs are required to be capitalized only after technical and commercial feasibility of the asset for sale or use have been established.

In sum, the national GAAP in many European countries and Australia generally differed from IFRS in two dimensions: (1) whether to expense R&D costs fully or partially and (2) whether R&D costs can or shall be capitalized if capitalization criteria are met. Table 1 summarizes the various accounting treatments of R&D under IFRS and pre-IFRS national GAAP.

Table 1
International differences in accounting treatments for R&D expenditures.

Classification	Research costs	Development costs
Mandatory expensing	Germany, Switzerland, UK, IFRS	Germany
Optional capitalization if certain conditions are met	Finland, France, Netherlands, Norway, Sweden	Finland, France, Netherlands, Norway, Switzerland, Sweden, UK
Mandatory capitalization if certain conditions are met	Australia	Australia, IFRS

Source: Agami and Monsen (1995), Jeny and Stolowy (1999), and Powell (2003).

2.2. Value relevance of R&D under different accounting treatments

An accounting number is considered value relevant if it has the expected relation with a company's stock price (Barth et al., 2001). Lev (1999) summarizes prior studies and concludes that R&D spending contributes significantly to a company's value creation and that the capital market incorporates these contributions in the company's stock price. However, R&D expenses reported under different accounting regimes embed various levels of uncertainty associated with future economic benefits. Depending on the specific accounting treatment of R&D under which companies report, management can convey information to stock markets regarding the economic substance of R&D activities. Prior studies have documented that the value relevance of R&D expenses varies under different accounting treatments (Healy et al., 2002; Oswald & Zarowin, 2007; Zhao, 2002).

Zhao (2002) studies the value relevance of R&D reporting in France, Germany, the UK, and the USA. He finds that R&D reporting generally enhances the value relevance of earnings and book value. In addition, he finds that while investors put a positive value on both expensed and capitalized R&D within countries allowing selective capitalization of R&D (i.e., France and the UK), capitalized R&D has a greater association with stock price than expensed R&D. Ahmed and Falk (2006) study the value relevance of R&D reporting choice in Australia. They also find that capitalized R&D is more value relevant than expensed R&D. Cazavan-Jeny, Jeanjean, and Joos (2011) examine the value relevance of R&D reporting in France between 1992 and 2001. Unlike prior studies that use simulated capitalized R&D, they use actual data on capitalized R&D and find that expensed R&D is negatively whereas capitalized R&D is insignificantly associated with concurrent stock prices and returns for firms that report both capitalized and expensed R&D. They attribute the finding to systematic differences in companies that choose to capitalize R&D because companies choosing to capitalize R&D are smaller, more highly leveraged, less profitable, and have fewer growth opportunities.

2.3. Differences between national GAAP and IFRS and changes in value relevance of R&D expenses

R&D projects are complex and tacit. The value of R&D outputs is better known to managers than outsiders. Companies can convey information to stock markets regarding the economic substance of R&D activities under different accounting treatments of R&D (Healy et al., 2002; Oswald & Zarowin, 2007). Prior studies also find that R&D information has different levels of relevance and reliability (e.g., Ahmed & Falk, 2006; Zhao, 2002). Therefore, we expect that the value relevance of R&D expenses changes as countries switch from their national GAAP to IFRS. The direction of the changes in the value relevance of R&D expenses depends on the nature of differences between national GAAP and IFRS.

2.3.1. Change from the mandatory expensing rule to IFRS

IFRS requires capitalization of development costs if certain conditions are met. Therefore, a switch from the mandatory expensing rule of R&D costs to IFRS suggests that part of the R&D expenditures meeting capitalization criteria be capitalized as assets, leaving the remaining R&D expenditures with uncertain future benefits expensed. Because the portion of R&D with highly certain future economic benefits is capitalized under IFRS, the reported R&D expenses under IFRS would be less value relevant than if the whole R&D expenditures were reported as expenses under the mandatory expensing rule. Thus, we expect that as the R&D accounting treatment changes from mandatory expensing to IFRS, the value relevance of R&D expenses declines. We state Hypothesis 1a in the alternative form as follows:

H1a. R&D expenses become less value relevant when the mandatory expensing rule is switched to IFRS.

2.3.2. Change from the optional capitalization rule to IFRS

The optional capitalization rule allows companies to exercise discretion to capitalize the portion of R&D costs that meet capitalization conditions. Consequently, not all R&D expenditures meeting capitalization criteria would be capitalized under the optional capitalization rule as under IFRS. In other words, reported R&D expenses are more likely to contain value enhancing R&D costs and thus more value relevant under the optional capitalization rule than the IFRS. As a result, we expect the value relevance of R&D expenses to decline after a switch

[6] Ding, Stolowy, & Tenenhaus (2007) observe that firms in France seldom choose to capitalize R&D costs. Their survey on the year 2000 annual reports of the 250 largest French listed companies shows that only 93 mention an R&D activity, and only 18 out of the 93 capitalize their R&D expenditures. Agami and Monsen (1995) summarize that each Nordic country generally permits either expensing or capitalizing R&D expenditures. Specifically, in Finland, if firms capitalize R&D expenditures as an intangible asset, firms should amortize the capitalization over its economic life. Norway, permits capitalization and amortization of R&D expenditures over a reasonable period when management has some evidence that the R&D costs are likely to have future benefits. Sweden allows the capitalization of R&D expenditures if certain conditions are met; firms should amortize the capitalization over a period that does not exceed five years. However, the common practice in Nordic countries is the immediate expensing of R&D expenditures. Jeny and Stolowy (1999) document that in the Netherlands R&D expenditures can be capitalized only if certain conditions are met. Overall, capitalization of research costs in these countries is rare and is presumably due to difficulties in differentiating between research and development costs (Powell, 2003).

[7] AASB 1011 Accounting for Research and Development Costs was issued in 1987 and requires R&D costs to pass a "beyond reasonable doubt" test in order to be capitalized. The capitalized R&D is to be amortized over the life of expected benefits starting when commercial production starts (Chan, Faff, Gharghori, & Ho, 2007; Goodwin & Ahmed, 2006).

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from the optional capitalization rule to IFRS. We state Hypothesis 1b in the alternative form as follows:

H1b. R&D expenses become less value relevant when the optional capitalization rule is switched to IFRS.

2.3.3. Change from the mandatory capitalization rule to IFRS

Under the mandatory capitalization rule, both research costs and development costs shall be capitalized if they meet capitalization conditions. Therefore, reported R&D expenses include little value enhancing R&D costs under the mandatory capitalization rule. As companies switch from the mandatory capitalization rule to IFRS, some value enhancing research costs that otherwise would be capitalized under the mandatory capitalization rule will be included in reported R&D expenses. As such, reported R&D expenses under IFRS would be more value relevant than under the mandatory capitalization rule. In sum, we expect that the value relevance of R&D expenses increases following a switch from the mandatory capitalization rule to IFRS. We state Hypothesis 1c in the alternative form as follows:

H1c. R&D expenses become more value relevant when the mandatory capitalization rule is switched to IFRS.

A plausible null hypothesis exists for the above predictions. That is, there will be no change in the value relevance of R&D expenses as national GAAP converge to IFRS. The capitalization of R&D costs under IFRS depends on management's subjective judgment. It is likely that management capitalize R&D costs as much as possible in order to spread out the expenses and maximize profits reported to shareholders (Cazavan-Jeny et al., 2011). On the other hand, managers of companies whose performance already exceeds certain thresholds or companies that plan to take tax benefits from R&D expensing would choose to expense R&D costs even though these costs qualify for capitalization (Zhao, 2002). Market participants foresee these ambiguities in management judgment in R&D reporting (Cazavan-Jeny & Jeanjean, 2006). As a result, investors may value R&D expenses reported under IFRS in a way that is not different from how R&D expenses are valued under other accounting regimes. Therefore, we may observe no change in the value relevance of R&D expenses after countries adopt IFRS.

3. Research design

3.1. Regression models

We employ a difference-in-differences design to assess the effect of IFRS adoption on changes in the value relevance of R&D expenses. To assess the differential effects of the convergence to IFRS from various pre-IFRS national GAAP on R&D value relevance, we use post-IFRS observations as the default while using dummy variables to capture three pre-IFRS accounting treatments.[8] Following prior literature on value relevance (e.g., Barth et al., 2001), we estimate the following pooled cross-sectional return and price models covering the pre- and post-IFRS periods across countries:

$$\begin{aligned} RET_{it} = {} & \beta_0 + \beta_1 E_{it} + \beta_2 CH\_E_{it} + \beta_3 RD_{it} + \beta_4 (RDit \times GAAP1_{it}) \\ & + \beta_5 (RD_{it} \times GAAP2_{it}) + \beta_6 (RD_{it} \times GAAP3_{it}) + \beta_7 (RD_{it} \times SIZE_{it}) \\ & + \beta_8 GAAP1_{it} + \beta_9 GAAP2_{it} + \beta_{10} GAAP3_{it} + \beta_{11} SIZE_{it} \\ & + \beta_{12} (E_{it} \times LOSS_{it}) + \beta_{13} (CH\_E_{it} \times LOSS_{it}) + \beta_{14} LOSS_{it} \\ & + \text{Country Fixed Effects} + \text{Industry Fixed Effects} \\ & + \text{Year Fixed Effects} + \varepsilon_{it} \end{aligned} \quad (1)$$

$$\begin{aligned} P_{it} = {} & \beta_0 + \beta_1 BVPS_{it} + \beta_2 EPS_{it} + \beta_3 RDPS_{it} + \beta_4 (RDPSit \times GAAP1_{it}) \\ & + \beta_5 (RDPS_{it} \times GAAP2_{it}) + \beta_6 (RDPS_{it} \times GAAP3_{it}) \\ & + \beta_7 (RDPS_{it} \times SIZE_{it}) + \beta_8 GAAP1_{it} + \beta_9 GAAP2_{it} + \beta_{10} GAAP3_{it} \\ & + \beta_{11} SIZE_{it} + \beta_{12} (BVPS_{it} \times LOSS_{it}) + \beta_{13} (EPS_{it} \times LOSS_{it}) \\ & + \beta_{14} LOSS_{it} + \text{Country Fixed Effects} + \text{Industry Fixed Effects} \\ & + \text{Year Fixed Effects} + \varepsilon_{it} \end{aligned} \quad (2)$$

where:

RET	is the annual stock return starting from the fourth month after the fiscal year-end t − 1 to the end of the third month after the fiscal year-end t, adjusted for dividends at year t,
E	is the income before extraordinary items and R&D expenses in fiscal year t scaled by the beginning market value of equity,
CH_E	is the change in net income before extraordinary items and R&D expenses between year t and t − 1 and scaled by the market value of equity at the fiscal year-end t − 1,
RD	is the R&D expenses in fiscal year t scaled by the beginning market value of equity,
P	is the stock price at the end of the fourth month after the fiscal year-end t (translated to US dollars using the spot exchange rate),[9]
BVPS	is the book value of equity per share at fiscal year-end t (translated to US dollars using the spot exchange rate),
EPS	is the income before extraordinary items and R&D expenses per share for fiscal year t (translated to US dollars using the average exchange rate over the fiscal year).
RDPS	is the R&D expenses per share in fiscal year t (translated to US dollars using the average exchange rate over the fiscal year),
LOSS	is an indicator variable that equals one if a firm's income before extraordinary items for fiscal year t is negative, zero otherwise,
SIZE	is measured as the natural logarithm of total assets at the fiscal year-end t (total assets are translated to US dollars using the spot exchange rate),
GAAP1	is an indicator (dummy) variable that equals one if a firm adopts an accounting treatment that requires mandatory expensing of research and development costs, zero otherwise,
GAAP2	is an indicator (dummy) variable that equals one if a firm adopts an accounting treatment that allows optional capitalization of development costs if certain conditions are met, zero otherwise,
GAAP3	is an indicator (dummy) variable that equals one if a firm adopts an accounting treatment that requires mandatory capitalization of development costs if certain conditions are met, zero otherwise.

All continuous regression variables are winsorized at the top and bottom 1% level. We use the fifteen industry groups as defined in Barth, Beaver, and Landsman (1998) to control for industry fixed effects. Error terms are clustered at the firm level. These variance estimates are robust in the sense of providing correct coverage rates much more than panel-level heteroskedasticity. In particular, they are robust to any type of correlation within the observations of each panel/group.

The three test variables for our hypotheses are the interaction terms between RD (RDPS) and three dummy variables (GAAP1, GAAP2, and GAAP3) in the return (price) model. Since we set IFRS as the default, our hypotheses predict the coefficients on (RD × GAAP1) and (RD × GAAP2) (RDPS × GAAP1) and RDPS × GAAP2) to be positive and the coefficient on (RD × GAAP3) (RDPS × GAAP3) to be negative in the return (price) model.

Following the valuation and value relevance literature (e.g., Ohlson, 1995; Zhao, 2002), we predict positive coefficients on E and CH_E (BVPS

[8] We use IFRS as the default for the ease of interpretation of the results because three types of R&D accounting treatments are examined before the adoption of IFRS by our sample countries. Alternatively, we can run three separate regressions. In each of the regressions, the default is one of the three pre-IFRS national GAAPs and post-IFRS is a dummy variable to capture the effects of IFRS adoption. The results from these three separate regressions are similar to the results we report in the paper.

[9] Hall, Grilliche, and Hausman (1986) point out that the flow of R&D expenditures is a fairly good proxy for long-run R&D behavior because of the low variance of the R&D series within a firm.

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Table 2
Sample distribution.

Panel A: sample distribution by fiscal year

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Australia	21	30	33	37	40	51	65	88	102	109	107	105	101	93	87	78	1147
Switzerland	9	10	10	9	12	13	12	14	12	11	12	15	15	15	15	15	199
Germany	31	32	41	49	72	82	89	93	86	84	96	100	97	93	89	82	1216
Finland	18	18	22	22	34	41	43	45	25	24	48	50	49	48	45	43	575
France	9	10	12	23	39	49	55	66	45	39	46	65	68	72	72	72	742
United Kingdom	109	127	134	159	183	201	224	240	152	138	203	204	191	173	161	157	2756
The Netherlands	8	5	5	7	11	11	11	13	13	12	15	16	17	15	13	12	184
Norway	2	2	2	5	10	12	11	12	6	6	11	10	10	8	8	9	124
Sweden	4	12	19	20	39	49	53	64	63	50	52	55	54	50	45	41	670
Total	211	246	278	331	440	509	563	635	504	473	590	620	602	567	535	509	7613

Panel B: sample distribution by R&D accounting treatment

Country	Mandatory expensing (GAAP1)	Optional capitalization (GAAP2)	Mandatory capitalization (GAAP3)	IFRS	Total
Australia			458	689	1147
Switzerland	55	40		104	199
Germany	422			794	1216
Finland		227		348	575
France	19	245		478	742
United Kingdom	2	1400		1354	2756
The Netherlands	27	51		106	184
Norway	10	51		63	124
Sweden		261		409	670
Total	535	2275	458	4345	7613

Based on the Compustat (Global) database, we identify the R&D accounting treatment a company uses in presenting its R&D expenses.

and EPS) in the return (price) model. To control for the effect of loss firms on the value relevance of earnings and book value (e.g., Hayn, 1995), we include LOSS, E × LOSS, and CH_E × LOSS in the return model and predict the coefficients to be negative. Similarly, we predict negative coefficients on LOSS and EPS × LOSS and a positive coefficient on BVPS × LOSS in the price model. To control for the firm size effect on the value relevance of R&D expenses, we include SIZE and an interaction term RD × SIZE (RDPS × SIZE) in the return (price) model and do not predict the sign of these variables.

3.2. Sample selection

We consider all IASB liaison countries that mandatorily adopted IFRS in 2005 and then narrow down to countries in which a large number of firms regularly conduct and report R&D activities. Our final sample includes companies from these nine countries: Australia, Finland, France, Germany, Netherlands, Norway, Sweden, Switzerland, and the UK. Since these countries adopted IFRS in 2005, we are able to obtain a sufficiently long period of data (1997–2012) to assess the changes in the value relevance of R&D expenses after IFRS adoption.

We collect the firm level financial data and foreign exchange rates from the Compustat Global database. Since the return-earnings regression model requires data of three continuous years (the previous year, the current year, and the next year), our initial sample includes 17,052 firm-year observations from 1996 to 2013.[10] We exclude 2846 firm-year observations without the required information and firms that did not adopt IFRS during the sample period 1997–2012 (1665 firm-year observations). We also drop 4928 firm-year observations related to firms that always use IFRS or accounting standards consistent with IFRS throughout the sample period. The final sample includes a total of 7613 observations related to firms that experienced a switch from national GAAP to IFRS between 1997 and 2012.

3.3. Descriptive statistics

Panel A of Table 2 presents the sample distribution by country and fiscal year. It shows that 36% of the firm-year observations come from the UK, 16% from Germany, and another 15% from Australia. 3268 observations are from fiscal years before IFRS adoption and 4345 observations thereafter. Panel B of Table 2 exhibits the sample distribution by R&D accounting standards. The panel shows that most of the firm-year observations use the optional capitalization rule on R&D costs before convergence to IFRS (2275 out of 3268 firm-year observations).

Table 3 presents the summary statistics for the main regression variables based on the 7613 firm-year observations. It shows that the mean of RET is 22.2%, which is much greater than the median (5.2%), even though continuous regression variables have been winsorized at the top and bottom 1% level. The mean of the income before extraordinary items and R&D expenses scaled by the beginning market value of equity (E) is less than the median, whereas the mean of CH_E is larger than the median. At least one quarter of the firm-year observations experienced decreases in income before extraordinary items and R&D expenses from the previous year. The mean of RD is about twice as large as the median. Regarding the variables used in the price model (P, BVPS, EPS, and RDPS), their distributions are still highly skewed after the variables are winsorized. A considerable number of the firm-year observations experience losses during the sample period (35% of all observations) and thus controlling for the effect of loss firms on the value relevance of earnings and book values is warranted. As indicated earlier, a great

Table 3
Summary statistics ($N = 7613$).

Variable	Mean	Std. dev.	Q1	Median	Q3
RET	0.222	0.829	−0.267	0.052	0.448
E	0.068	0.238	0.005	0.081	0.146
CH_E	0.033	0.264	−0.029	0.010	0.055
RD	0.089	0.124	0.017	0.047	0.107
P	22.063	68.498	0.964	4.300	15.540
BVPS	12.024	39.209	0.400	2.007	7.165
EPS	2.353	8.572	0.003	0.289	1.329
RDPS	1.089	3.725	0.031	0.143	0.602
LOSS	0.352	0.478	0	0	1
SIZE	5.271	2.505	3.514	4.905	6.837
GAAP1	0.070	0.256	0	0	0
GAAP2	0.299	0.458	0	0	1
GAAP3	0.060	0.238	0	0	0

[10] We organize the observations by fiscal years.

Please cite this article as: Gong, J.J., & Wang, S.I.-L., Changes in the value relevance of research and development expenses after IFRS adoption, *Advances in Accounting, incorporating Advances in International Accounting* (2016), http://dx.doi.org/10.1016/j.adiac.2016.05.002

Table 4
Spearman and Pearson correlation matrix ($N = 7613$).

Variable	RET	E	CH_E	RD	P	BVPS	EPS	RDPS	LOSS	SIZE
RET	1.00	0.27	0.27	0.13	0.20	0.06	0.14	0.02	−0.16	0.05
E	0.09	1.00	0.43	0.22	0.37	0.39	0.70	0.39	−0.69	0.28
CH_E	0.21	0.35	1.00	0.11	0.06	0.02	0.25	0.04	−0.29	0.00
RD	0.23	0.25	0.19	1.00	−0.19	−0.12	−0.07	0.40	0.27	−0.30
P	0.05	0.14	0.00	−0.01	1.00	0.88	0.78	0.72	−0.50	0.67
BVPS	−0.01	0.24	0.01	0.16	0.75	1.00	0.74	0.72	−0.45	0.67
EPS	0.00	0.32	0.08	0.17	0.75	0.89	1.00	0.62	−0.73	0.56
RDPS	−0.01	0.24	0.02	0.26	0.69	0.86	0.88	1.0	−0.23	0.39
LOSS	−0.02	−0.54	−0.14	0.20	−0.18	−0.15	−0.21	−0.12	1.00	−0.45
SIZE	−0.06	0.22	−0.04	−0.17	0.23	0.25	0.24	0.20	−0.43	1.00

Spearman correlation above and Pearson correlation below diagonal.
The absolute value of correlation greater than 0.04 (0.03) is significant at 1% (5%).

number of the firm-year observations adopt the optional capitalization rule on R&D reporting before convergence to IFRS (about 30% of all observations).

Table 4 shows the correlations among the main regression variables. As shown in the table, RET is significantly correlated with E and CH_E in the predicted direction and RD is positively correlated with RET. Similarly, P is significantly correlated with BVPS, EPS, and RDPS.

4. Empirical results

4.1. Pre-IFRS accounting standards and changes in value relevance of R&D expenses

Table 5 presents the regression results of Eqs. (1) and (2) on the return–earnings relation (column (1)), the price–book value–earnings relation (column (2)), and R&D expenses and its interactions with R&D accounting treatment indicator variables, with IFRS as the default. Column (1) of Table 5 shows that the R&D expenses under IFRS are value relevant (coefficient = 1.045, p-value < 0.01). Column (1) also shows that the coefficient on RD*GAAP1 is positive (1.070) and significant (p-value < 0.01), suggesting that the value relevance of R&D expenses under the mandatory expensing rule is significantly higher than that under IFRS. Therefore, the value relevance of R&D expenses declines as national GAAP following mandatory expensing is replaced by IFRS, consistent with our Hypothesis 1a.

Column (1) of Table 5 also shows that the coefficient on RD*GAAP2 is positive (0.937) and significant (p-value < 0.01), suggesting that the value relevance of R&D expenses under optional capitalization is higher than that under the IFRS. This means that the value relevance of R&D expenses declines as a country switches its R&D accounting from its national GAAP following optional capitalization to IFRS, consistent with our Hypothesis 1b.

Column (1) of Table 5 reports that the coefficient on RD*GAAP3 is positive (0.079) but insignificant (p-value > 0.1), suggesting that the value relevance of R&D expenses under mandatory capitalization is not different from that under IFRS. This means that the value relevance of R&D expenses does not change as IFRS replaces national GAAP that mandates R&D capitalization when capitalization conditions are met. Our Hypothesis 1c is not supported. We conjecture that the insignificant change is probably due to the slight difference between the two accounting regimes. IFRS does not allow whereas the mandatory capitalization rule requires capitalization of economically viable research costs.

Table 5
Changes in value relevance of R&D expenses.
Differences between Pre-IFRS national GAAP and IFRS.

From mandatory expensing (*GAAP1*)/optional capitalization (*GAAP2*)/mandatory capitalization (*GAAP3*) to IFRS							
Model (1) RET				Model (2) P			
Variable	Pred.	Coeff.	t-stat.	Variable	Pred.	Coeff.	t-stat.
E	+	0.542***	4.18	BVPS	+	0.208	0.88
CH_E	+	0.539***	5.61	EPS	+	5.191***	4.26
RD	+	1.045***	3.61	RDPS	+	4.828	1.24
RD*GAAP1	+	1.070***	2.65	RDPS*GAAP1	+	−0.213	−0.09
RD*GAAP2	+	0.937***	3.30	RDPS*GAAP2	+	−0.895	−0.43
RD*GAAP3	−	0.079	0.13	RDPS*GAAP3	−	4.210	0.36
RD*SIZE		−0.154***	−2.85	RDPS*SIZE		−0.916**	−2.14
GAAP1		−0.184***	−3.64	GAAP1		−13.740	−1.54
GAAP2		−0.104**	−2.26	GAAP2		−9.043	−1.21
GAAP3		−0.102*	−1.67	GAAP3		−9.847	−1.51
SIZE		−0.001	−0.21	SIZE		1.429***	3.44
E*LOSS	−	−0.885***	−5.88	BVPS*LOSS	+	0.503**	1.80
CH_E*LOSS	−	−0.217**	−1.82	EPS*LOSS	−	−3.931**	−2.17
LOSS	−	−0.059**	−2.13	LOSS	−	−0.548	−0.40
Avg. VIF		2.99				3.59	
Max. VIF		7.86				20.46	
No. of obs.		7613				7613	
No. of clusters		848				848	
Adj. R^2		0.30				0.68	

All regressions are controlled for industry, country, and year effects and error terms are clustered at the firm level.
One tailed for coefficients with predicted signs, and two tailed otherwise.
* Denotes significance level at 10%.
** Denotes significance level at 5%.
*** Denotes significance level at 1%.

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As for control variables, earnings (E) and change in earnings (CH_E) are positively and significantly related to stock prices, consistent with prior studies (Barth et al., 2001). The coefficients on LOSS, E*LOSS, and CH_E*LOSS are all negative and significant, suggesting that loss-reporting companies are valued differently from profit-making ones, consistent with prior studies (e.g., Hayn, 1995).

Column (2) of Table 5 presents the regression results of the price model. An advantage of the price model over the return model is to control for the effect of capitalized R&D assets, if any, on the market valuation of firms' R&D activities through the inclusion of the book value (BVPS). The results show that neither the RDPS nor the interaction terms between RDPS and R&D accounting treatment indicator variables are significant. In addition, markets weigh BVPS only for loss firms in valuation. Nonetheless, there is a strong and significant association between equity price and accounting earnings. Together, the results do not support a significant association between equity price and R&D expenses in our sample countries before or after the convergence to IFRS. The findings are consistent with Cazavan-Jeny et al. (2011) that use the price model and actual capitalized R&D data, and find lack of value relevance of capitalized and expensed R&D expenditures in the pre-IFRS era in France.

4.2. Additional analysis of national institutions and their effects on changes in value relevance of R&D

Echoing comments by Ball (2006), Pope and McLeay (2011) and ICAEW (2015) review studies on mandatory IFRS adoption in the EU and conclude that the effects of IFRS adoption are not uniform in the EU, as a result of differences in preparers' incentives and local enforcement mechanisms. In this study we follow new institutional economics to identify national institutional factors to focus on. North (1991) classifies institutions into formal rules, informal rules, enforcement, and social norms. Accounting standards are formal rules. Therefore, we focus on the latter three institutional factors in this part of the analysis. We use an index of financial reporting culture based on Leuz, Nanda, and Wysocki (2003) as a proxy for informal rules of financial reporting. We use a measure of investor protection used by DeFond et al. (2007) as a proxy for the enforcement of formal and informal rules. Finally, we include the uncertainty avoidance dimension in the national culture measurement created by Hofstede, Hofstede, and Minkov (2010) to measure social norms.

Leuz et al. (2003) measure earnings management in four dimensions:

(1) the smoothing of reported operating earnings using accruals,
(2) the correlation between changes in accounting accruals and operating cash flows,
(3) the magnitude of accruals, and
(4) small loss avoidance.

We follow Leuz et al. (2003) and construct the above four measures for 24 countries every fiscal year.

We use 24 countries in the ranking procedure, including the nine countries examined in this study, to allow for more variations in our measure for the national financial reporting culture. The appendix lists all 24 countries used in the ranking procedure (see the variable definition of FinRepCul). The four dimensions of earnings management are determined as follows. First, the smoothing of reported operating earnings using accruals is measured as a country's median ratio of the firm-level standard deviation of the operating earnings over that of the cash flows from operations over a three-year period. Second, we calculate the contemporaneous Spearman correlation between changes in accounting accruals and changes in operating cash flows every fiscal year for every country. Third, we measure the magnitude of accruals as a country's median ratio of the absolute value of accruals over the absolute value of operating cash flows every fiscal year. Fourth, small loss avoidance is calculated as the natural logarithm of the number of small profit occurrences plus one over the number of small loss occurrences plus one every fiscal year for every country. Small profit or loss is defined as when a firm's net income is within $\pm 1\%$ of its beginning total assets.

We then rank the four dimensions of earnings management among 24 countries in an order that a higher rank suggests reported earnings are less subject to management manipulation at the national level. We define FinRepCul as the average ranking of the four dimensions of earnings management for each country every fiscal year. Thus, higher FinRepCul reflects a lower probability that earnings management is a common practice in financial reporting within a country.

Following DeFond et al. (2007) and Durnev and Nain (2007), we measure investor protection (InvProStrength) by incorporating the history of insider trading law enforcement as well as the strictness of insider trading laws. Specifically, it is the product of the strictness of insider trading law and the natural logarithm of the number of years since the first insider law enforcement in a country.

To simplify the regression model, we use one of the six dimensions of national culture developed by Hofstede et al. (2010), uncertainty avoidance index (UAI), as the third national institutional factor. A higher index indicates members of a society to feel more uncomfortable about and intolerant of uncertainty and ambiguity. People in countries with high UAI attempt to minimize the possibility of the unstructured situations that are novel, unknown, surprising, and different from usual more than people in countries with low UAI. We believe that UAI is the most relevant cultural characteristic to valuation of such an uncertain economic phenomenon as R&D.

Our examination of the institutional factors is exploratory. Therefore, we do not make directional predictions on the two-way and three-way interaction terms involving national institutional factors in Eqs. (3) and (4). Significant coefficients on the interaction terms between reported R&D expenses, R&D accounting treatments, and national institutional factors would suggest that national institutional factors play a role in the market valuation of R&D expenses under national GAAP relative to IFRS.

Empirically, we expand Eqs. (1) and (2) by including three institutional factors: financial reporting culture, investor protection strength, and uncertainty avoidance. Prior international accounting literature has documented the effect of national institutional factors on the properties of accounting earnings and book values (e.g., Ali & Hwang, 2000; Ball, Kothari, & Robin, 2000). We extend prior literature to examine the effect of national financial reporting culture and investor protection on the value relevance of R&D expenses. We choose not to examine the effect of legal systems (that is, common versus code law systems) on the value relevance of R&D expenses conditional on R&D accounting standards due to limited variation in the types of legal system our sample countries adopt and potential multicollinearity issues. For example, Australia is our only sample country that follows the mandatory capitalization rule. Therefore, we are unable to examine whether a common law legal system impacts the value relevance of R&D expenses differently from a code law legal system. While national culture has been examined in the context of earnings management across countries (e.g., Han, Kang, Salter, & Yoo, 2010; Nabar & Boonlert-U-Thai, 2007), we are not aware of any studies examining the effect of national culture on the value relevance of accounting earnings or R&D expenses. Because the outcomes of R&D activities are relatively uncertain in nature, it is of interest to see whether national culture plays a role in the market valuation of reported R&D expenses conditional on various R&D accounting treatments. We follow this line of research and examine particularly whether the national level of uncertainty avoidance, which is one of the six dimensions of national culture developed by Hofstede et al. (2010), plays a role in the value relevance

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of reported R&D expenses conditional on R&D accounting treatments.

Including these three institutional factors results in the following equations:

$$\begin{aligned}RET_{it} = {} & \beta_0 + \beta_1 E_{it} + \beta_2 CH\_E_{it} + \beta_3 RD_{it} + \beta_4 (RD_{it} \times GAAP1_{it}) \\ & + \beta_5 (RD_{it} \times GAAP2_{it}) + \beta_6 (RD_{it} \times GAAP3_{it}) \\ & + \beta_7 (RD_{it} \times FinRepCul_{kt}) + \beta_8 (RD_{it} \times FinRepCul_{kt} \times GAAP1_{it}) \\ & + \beta_9 (RD_{it} \times FinRepCul_{kt} \times GAAP2_{it}) \\ & + \beta_{10} (RD_{it} \times FinRepCul_{kt} \times GAAP3_{it}) \\ & + \beta_{11} (RD_{it} \times InvProStrength_{kt}) \\ & + \beta_{12} (RDit \times InvProStrength_{kt} \times GAAP1_{it}) \\ & + \beta_{13} (RD_{it} \times InvProStrength_{kt} \times GAAP2_{it}) \\ & + \beta_{14} (RD_{it} \times InvProStrength_{kt} \times GAAP3_{it}) + \beta_{15} (RD_{it} \times UAI_k) \\ & + \beta_{16} (RD_{it} \times UAI_k \times GAAP1_{it}) + \beta_{17} (RD_{it} \times UAI_k \times GAAP2_{it}) \\ & + \beta_{18} (RD_{it} \times SIZE_{it}) + \beta_{19} GAAP1_{it} + \beta_{20} GAAP2_{it} + \beta_{21} GAAP3_{it} \\ & + \beta_{22} FinRepCul_{kt} + \beta_{23} InvProStrength_{kt} + \beta_{24} UAI_k + \beta_{25} SIZE_{it} \\ & + \beta_{26} (E_{it} \times LOSS_{it}) + \beta_{27} (CH\_E_{it} \times LOSS_{it}) + \beta_{28} LOSSit \\ & + \text{Industry Fixed Effects} + \text{Year Fixed Effects} + \varepsilon_{it} \end{aligned} \quad (3)$$

$$\begin{aligned}P_{it} = {} & \beta_0 + \beta_1 BVPS_{it} + \beta_2 EPS_{it} + \beta_3 RDPS_{it} + \beta_4 (RDPS_{it} \times GAAP1_{it}) \\ & + \beta_5 (RDPS_{it} \times GAAP2_{it}) + \beta_6 (RDPS_{it} \times GAAP3_{it}) \\ & + \beta_7 (RDPS_{it} \times FinRepCul_{kt}) + \beta_8 (RDPS_{it} \times FinRepCul_{kt} \times GAAP1_{it}) \\ & + \beta_9 (RDPS_{it} \times FinRepCul_{kt} \times GAAP2_{it}) \\ & + \beta_{10} (RDPS_{it} \times FinRepCul_{kt} \times GAAP3_{it}) \\ & + \beta_{11} (RDPS_{it} \times InvProStrength_{kt}) \\ & + \beta_{12} (RDPSit \times InvProStrength_{kt} \times GAAP1_{it}) \\ & + \beta_{13} (RDPS_{it} \times InvProStrength_{kt} \times GAAP2_{it}) \\ & + \beta_{14} (RDPS_{it} \times InvProStrength_{kt} \times GAAP3_{it}) + \beta_{15} (RDPS_{it} \times UAI_k) \\ & + \beta_{16} (RDPS_{it} \times UAI_k \times GAAP1_{it}) + \beta_{17} (RDPS_{it} \times UAI_k \times GAAP2_{it}) \\ & + \beta_{18} (RDPD_{it} \times SIZE_{it}) + \beta_{19} GAAP1_{it} + \beta_{20} GAAP2_{it} + \beta_{21} GAAP3_{it} \\ & + \beta_{22} FinRepCul_{kt} + \beta_{23} InvProStrength_{kt} + \beta_{24} UAI_k + \beta_{25} SIZE_{it} \\ & + \beta_{26} (BVPS_{it} \times LOSS_{it}) + \beta_{27} (EPS_{it} \times LOSS_{it}) + \beta_{28} LOSSit \\ & + \text{Industry Fixed Effects} + \text{Year Fixed Effects} + \varepsilon_{it} \end{aligned} \quad (4)$$

where:

FinRepCul (average financial reporting culture) is a proxy for the financial reporting culture within country k,

InvProStrength (investor protection strength) is the product of the strictness of insider trading law in country k and the natural logarithm of the number of years passed since the first enforcement of insider trading laws for each country in fiscal year t.

UAI (uncertainty avoidance index) is one of the six dimensions of national culture developed by Hofstede et al. (2010) measuring "the degree to which the members of a society feel uncomfortable with uncertainty and ambiguity" in country k.

The other variables are defined previously in Eqs. (1) and (2). All variable definitions are summarized in the Appendix A.

Financial reporting culture scores are based on the national level of earnings management developed in Leuz et al. (2003); higher scores indicate that reported earnings are less subject to earnings manipulation at the national level.

The years in which insider trading law was first enforced in our sample countries are obtained from Bhattacharya and Daouk (2002) and DeFond et al. (2007). The strictness of insider trading law considers the *scope*, *sanction* and *private right*, covering five individual components (Beny, 2005; Durnev & Nain, 2007). We assign one point for each individual component if present and the strictness of insider trading law is then the sum of points received under these five individual components.

Scope measures the breadth of the insider trading prohibition and covers two individual components. First, if corporate insiders are prohibited from tipping outsiders (tippees) about material nonpublic information and/or encouraging them to trade on such information for personal gain, this individual component receives one point. Second, if tippees are prohibited from trading on material nonpublic information that they have received from corporate insiders, this individual component receives another point.

Sanction measures the expected criminal and monetary sanctions for violating a country's insider trading laws and covers two individual components as well. First, if the monetary penalty for violating insider trading laws is potentially greater than the insiders' trading profits, this component receives one point. Second, if violation of insider trading laws is a potential criminal offense, this component also receives one point.

Private right receives one point if private parties have a private right of action against parties who have violated the country's insider trading laws.

Table 6 panel A provides the national financial reporting culture scores by country and fiscal year. The possible range for the financial reporting culture score is from 1 to 24. The average scores of our sample countries during the sample period of 1997–2012 range from 10.2 to 19.7. Within a country, the measure shows some variation over time as well by construction. This suggests that the measure captures some effect not included in country fixed effects.

Panel B shows the year in which the insider trading laws were first enforced in each country, and that by 1996 insider trading laws were enforced in all sample countries.

Panel C depicts the five components determining the strictness of insider trading law for each sample country whereas panel D presents the UAI for each sample country. UAI is time invariant for each country and ranges from 29 to 86 for our sample countries. Panel E reports the descriptive statistics of these institutional factors used in the analysis. The mean of the national financial reporting culture scores (FinRepCul) is higher than the equally-weighted mean (14.8, not reported in the table), showing that the sample set includes more observations from countries where reported earnings are less likely subject to earnings management. The means (medians) of InvProStrength and UAI are 8.863 and 49.738 (8.987 and 51), respectively.

Table 7 reports the regression results of Eqs. (3) and (4) and provides some insights about the roles of national institutional factors in the market valuation of R&D activities.[11] First, column (1) of Table 7 shows that the interaction terms RD × FinRepCul, RD × InvProStrength, and RD × UAI are all significant (*p*-values are 10%, 10%, and 5%, respectively). These results suggest that national institutional factors are important in influencing the value relevance of R&D expenses before and after IFRS adoption, which is consistent with Ball (2006).

Column (1) of Table 7 also shows that coefficients on RD and RD × GAAP1 are not significant while RD × InvProStrength and RD × GAAP1 × InvProStrength are positively and significantly associated with stock returns. The positive and significant coefficient on RD × GAAP1 × InvProStrength suggests that R&D expenses are more value relevant under mandatory expensing than under IFRS in countries with stronger investor protection. In other words, the effects documented in the section on pre-IFRS accounting standards and changes in value relevance of R&D expenses that the value relevance of R&D expenses declines after IFRS replaces the mandatory expensing rule are greater in countries with stronger investor protection. This is yet another piece of evidence that national institutional factors influence the way markets value accounting information besides accounting standards (Ball, Robin, & Wu, 2003).

In addition, the coefficients on RD × GAAP2 and RD × GAAP2 × UAI are significant at the 5% level. The results show that after controlling for national institutional factors, the way markets value R&D expenses remains different under the optional capitalization rule than IFRS and are consistent with our prediction. That is, unlike IFRS, which requires capitalization of development costs when certain conditions are met, the optional capitalization rule allows firms the choice to capitalize R&D expenditures when certain conditions are met. Consequently, markets value reported R&D expenses higher under the optional

[11] We focus our discussion on the two-way and three-way interaction terms among, RD, accounting treatment indicator variables, and three national institutional factors because the results of other variables are similar to the findings in Table 5.

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Table 6
Descriptive statistics of national institutions.

Panel A: financial reporting culture scores by country and fiscal year

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
Australia	18	14.5	21	21.25	20.25	21.25	23	18.25	21.75	18.25	22.5	19.75	17	20.75	16.5	21	19.7
Switzerland	16	7	6.75	15.5	12	11.5	12.25	12.75	15.25	13.75	10.75	11.5	20.25	12.5	12.75	14.5	12.8
Germany	8.5	10	6.75	10.5	11.5	13.5	7.75	13	7	11.75	9	13	13.75	16.25	16.25	14.75	11.5
Finland	12	16.5	14.5	13	17.25	17.25	17.5	20.25	17	19.5	9.5	16.25	9.5	14.5	17	11.25	15.2
France	14.5	9	14.25	10	12.25	10	9.25	7.25	6.25	7.75	7.5	10.5	12.25	9.75	9.5	12.75	10.2
United Kingdom	10.5	16.75	17	18.25	12.5	14.5	15.25	19.5	19.75	17.5	19	20	19.5	18	17.5	16.75	17
The Netherlands	16.25	16	17.25	19.75	15	20	12.25	7.75	16.5	12	18.25	11.25	14.75	12.75	13	13.75	14.8
Norway	15.75	17	17.5	16	14.5	16.75	15.25	13.75	21.25	17	8.25	11	12.25	11.5	12.25	12.5	14.5
Sweden	18.75	14.75	15.5	19.5	13.75	18.5	17	17.25	16.25	20.25	19.5	20.5	22.25	19.75	12.25	19.25	17.8

Panel B: year in which insider trading law was first enforced by country

Country	First enforcement of insider trading law
Australia	1996
Switzerland	1995
Germany	1995
Finland	1993
France	1975
United Kingdom	1981
The Netherlands	1994
Norway	1990
Sweden	1990

Panel C: strictness of insider trading law

	Scope	Sanction	Insider trading law	Private rights	Strictness of insider trading law
Country	(1)	(2)	(3) = (1) + (2)	(4)	(5) = (3) + (4)
Australia	2	1	3	1	4
Switzerland	2	1	3	0	3
Germany	2	1	3	0	3
Finland	2	1	3	0	3
France	2	2	4	0	4
United Kingdom	2	1	3	0	3
The Netherlands	2	1	3	0	3
Norway	1	0	1	0	1
Sweden	2	1	3	0	3
Overall average	1.8	1	2.8	0.1	2.9

Panel D: uncertainty avoidance index (UAI) by country

Australia	51
Switzerland	58
Germany	65
Finland	69
France	86
United Kingdom	35
The Netherlands	53
Norway	50
Sweden	29

Panel E: summary statistics of national institutions

Variable	Mean	Std. dev.	Q1	Median	Q3	*N*
FinRepCul	15.703	4.088	12.500	16.750	19.250	7613
InvProStrength	8.863	2.390	7.695	8.987	9.940	7613
UAI	49.738	17.048	35.000	51.00	65.00	7613

capitalization rule than IFRS. Although UAI moderates the relation under the optional capitalization rule, the roles of financial reporting culture and investor protection strength in the market valuation of R&D expenses are no different after the convergence to IFRS. In other words, in a financial reporting environment that allows firms to choose capitalization of R&D assets when R&D activities are deemed economically feasible, markets with high uncertainty avoidance consider such options and reflect negatively in the market valuation of R&D expenses. Also, RD × GAAP3 is insignificant in both Tables 5 and 7, but the interaction term RD × GAAP3 × InvProStrength is significant at the 5% level. The results suggest that generally markets do not value R&D expenses differently when a country switches from the mandatory capitalization rule to IFRS. However, considering the level of national investor protection strength, markets value R&D expenses differently under the mandatory capitalization rule than IFRS. As such, national investor protection strength appears to be a critical institutional factor before the convergence from the mandatory capitalization rule to IFRS.

We note potential multicollinearity issues in Eq. (3) because several interaction terms are associated with RD. While it is a natural course that including products of the variables may lead to high variance

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Table 7
Additional analysis on changes in value relevance of R&D expenses.
R&D accounting treatments and national institutional factors.

From mandatory expensing (*GAAP1*)/optional capitalization (*GAAP2*)/mandatory capitalization (*GAAP3*) to IFRS										
		Model (1) RET		Model (2) RET				Model (3) P		Model (4) P	
Variable	Pred.	Coeff.	t-stat.	Coeff.	t-stat.	Variable	Pred.	Coeff.	t-stat.	Coeff.	t-stat.
E	+	0.545***	4.16	0.533***	4.09	BVPS	+	0.460**	1.95	0.469**	1.99
CH_E	+	0.548***	5.61	0.547***	5.58	EPS	+	5.509***	3.77	5.237***	3.55
RD	+	−0.576	−0.49	0.469	0.45	RDPS	+	1.877	0.28	−2.344	−0.38
RD*GAAP1	+	2.039	0.35	0.881	1.97	RDPS*GAAP1	+	4.182	0.21	−6.428	−2.42
RD*GAAP2	+	4.748**	2.06	1.010	3.50	RDPS*GAAP2	+	−23.931	−3.24	−3.974	−1.79
RD*GAAP3	−	0.474	0.10	−0.327	−0.50	RDPS*GAAP3	−	−48.106	−1.02	6.322	0.63
RD*FinRepCul		0.085*	1.66	0.048	1.10	RDPS*FinRepCul		−0.058	−0.24	0.123	0.63
RD*GAAP1*FinRepCul		−0.168	−1.06			RDPS*GAAP1*FinRepCul		0.061	0.23		
RD*GAAP2*FinRepCul		−0.128	−1.56			RDPS*GAAP2*FinRepCul		0.421	1.17		
RD*GAAP3*FinRepCul		0.180	0.83			RDPS*GAAP3*FinRepCul		2.444	0.98		
RD*InvProStrength		−0.094*	−1.95	−0.078	−1.63	RDPS*InvProStrength		−1.007**	−2.01	−1.360***	−4.42
RD*GAAP1* InvProStrength		0.516***	3.18			RDPS*GAAP1* InvProStrength		−0.263	−0.26		
RD*GAAP2* InvProStrength		−0.030	−0.25			RDPS*GAAP2* InvProStrength		−1.135*	−1.86		
RD*GAAP3* InvProStrength		−0.602**	−2.07			RDPS*GAAP3* InvProStrength		0.937	0.26		
RD*UAI		0.022**	2.29	0.011	1.17	RDPS*UAI		0.216**	2.13	0.319***	4.19
RD*GAAP1*UAI		−0.039	−0.45			RDPS*GAAP1*UAI		−0.143	−0.47		
RD*GAAP2*UAI		−0.031**	−2.03			RDPS*GAAP2*UAI		0.374***			
RD*SIZE		−0.148**	2.41	−0.146**	−2.39	RDPS*SIZE		−1.151***	−3.35	−1.264***	−4.02
GAAP1		−0.158***	−2.97	−0.169***	−3.22	GAAP1		8.946	1.15	10.710	1.37
GAAP2		−0.110**	−2.20	−0.105**	−2.24	GAAP2		5.156	0.74	6.608	0.92
GAAP3		−0.020	−0.34	−0.002	−0.04	GAAP3		2.000	0.33	3.816	0.63
FinRepCul		−0.001	−0.37	−0.002	−0.52	FinRepCul		−0.594**	−2.50	−0.512**	−2.08
InvProStrength		0.006	1.16	0.006	1.23	InvProStrength		0.286	0.51	0.377	0.69
UAI		−0.001	−1.28	−0.001	−1.43	UAI		0.061	1.08	0.072	1.24
SIZE		−0.003	−0.73	−0.003	0.74	SIZE		1.667***	4.72	1.646	4.69
E*LOSS		−0.885***	−5.84	0.883***	−5.83	BVPS*LOSS		0.373	1.14	0.343	1.06
CH_E*LOSS		−0.234*	−1.94	−0.224	−1.84	EPS*LOSS		−3.821**	1.95	−3.985**	−2.02
LOSS		−0.060**	−2.14	−0.259**	−2.12	LOSS		−0.282	−0.22	−0.498	−0.39
Avg. VIF		33.1		8.4		Avg. VIF		33.21		7.35	
Max. VIF		341.3		119.9		Max. VIF		525.88		92.09	
No. of obs.		7613		7613		N		7613		7613	
No. of clusters		848		848		No. of clusters		848		848	
Adj. R^2		0.31		0.31		Adj. R^2		0.70		0.69	

All regressions are controlled for industry and year effects and error terms are clustered at firm level.
One tailed for coefficients with predicted signs, and two tailed otherwise.
* Denotes significance level at 10%.
** Denotes significance level at 5%.
*** Denotes significance level at 1%.

inflation factors (VIFs), the *p*-values of these products are not affected by multicollinearity. Nonetheless, we remove all three-way interaction terms from Eq. (3) to lower multicollinearity and report the results in column (2) of Table 7. The results are similar to the ones reported in Table 5 after controlling for national institutional factors. One possible explanation for the insignificant interaction terms between RD and national institutional factors could be that the effects of national institutional factors on the value relevance of R&D expenses are muted without properly differentiating the effects specific to various R&D accounting treatments.

Taken together, the results suggest that while the convergence to IFRS among sample countries eliminates the differences in R&D accounting treatments, the role of national institutional factors remains critical in the value relevance of R&D expenses. Specific impacts of national institutional factors on the changes in the value relevance of R&D expenses depend on pre-IFRS national GAAP. For instance, markets with stronger national investor protection that use either the mandatory expensing or the mandatory capitalization rule experience greater changes in the value relevance of R&D expenses after the convergence to IFRS. On the other hand, markets with higher uncertainty avoidance that use the optional capitalization rule experience smaller changes in the R&D value relevance following the IFRS adoption.

Column (3) of Table 7 presents the results based on Eq. (4). We are interested in investigating the role of national institutional factors in market valuations of R&D expenses conditional on various R&D accounting treatments after the effect of capitalized R&D assets, if any, is considered through the inclusion of book value. Similar to the findings in Table 5, we find no significant associations between RD and R&D accounting treatment indicator variables. However, both the national investor protection strength and the national level of uncertainty avoidance play a significant role in market valuations of R&D expenses conditional on R&D accounting treatments (RDPS × InvProStrength, RDPS × GAAP2 × InvProStrength, RDPS × UAI, and RDPS × GAAP2 × UAI are significant at the 10%, 5%, and 1% level, respectively). Specifically, the way markets that experience convergence from either the mandatory expensing or the mandatory capitalization rule to IFRS value R&D expenses similarly after convergence to IFRS conditional on the strength of investor protection and level of uncertainty avoidance.

On the other hand, the weights of investor protection strength and uncertainty avoidance on market valuations of R&D expenses are attenuated for markets that switch from the optional capitalization rule to IFRS. Last, we do not find the coefficients on any interaction terms associated with FinRepCul significant. To assess potential multicollinearity issues, we also report regression results after removing all three-way interaction terms in column (4) of Table 7 and the results are qualitatively similar. In sum, national investor protection strength and level of uncertainty avoidance consistently play a role in market valuations of R&D activities in the price model. The weights of national institutional factors are attenuated in market valuations of R&D expenses following the switch from the optional capitalization rule to IFRS.

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Table 8
Additional analysis on value relevance of R&D expenses after IFRS adoption.
National institutional factors and pre-, during, and post-financial crisis.

From mandatory expensing (*GAAP1*)/optional capitalization (*GAAP2*)/mandatory capitalization (*GAAP3*) to IFRS

		Model (1) RET		Model (2) RET		Model (3) RET				Model (4) P		Model (5) P		Model (6) P	
		Prior to financial crisis		During financial crisis		After financial crisis				Prior to financial crisis		During financial crisis		After financial crisis	
		1/1/05 to 12/31/07		1/1/08 to 12/31/09		1/1/10 to 12/31/13				1/1/05 to 12/31/07		1/1/08 to 12/31/09		1/1/10 to 12/31/13	
Variable	Pred.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.	Variable	Pred.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
E	+	0.785***	2.15	0.733***	2.70	0.733***	3.32	BVPS	+	1.241***	2.51	0.675**	2.36	0.310	0.99
CH_E	+	0.685***	2.15	0.329*	1.61	0.569***	3.95	EPS	+	5.183*	1.51	3.782***	2.68	4.165**	1.69
RD	+	−3.942	−1.41	−0.780	−0.30	−1.988	−0.95	RDPS	+	−17.810	−1.42	8.472*	1.43	35.468***	3.92
RD*FinRepCul		0.160	1.38	0.145	1.24	0.091	1.09	RDPS*FinRepCul		0.403	1.13	0.076	0.89	−0.628*	−1.96
RD*InvProStrength		0.084	0.54	−0.428***	−3.54	0.049	0.67	RDPS*InvProStrength		−2.335***	−3.65	−2.030***	−4.75	−2.372***	−6.70
RD*UAI		0.035	1.06	0.053*	1.95	0.011	0.86	RDPS*UAI		0.548***	6.71	0.300***	5.26	0.232***	3.91
RD*SIZE		−0.210**	−2.22	0.300	0.36	−0.068	−1.02	RDPS*SIZE		−0.893	01.20	−1.188***	−3.34	−2.312***	−4.72
FinRepCul		0.004	0.45	−0.005	−0.46	−0.005	−0.63	FinRepCul		−0.745**	−2.30	0.137	0.38	−0.400	−1.19
InvProStrength		0.000	0.03	0.024*	1.69	0.005	0.75	InvProStrength		2.809**	2.50	1.471*	1.76	0.938	1.56
UAI		0.002	0.87	−0.004	−1.45	−0.004***	−2.76	UAI		−0.024	−0.21	−0.111	−1.15	0.043	0.48
SIZE		−0.014	−1.22	0.004	0.46	−0.004	−0.57	SIZE		0.126	0.16	0.908**	1.98	2.731***	5.80
E*LOSS	−	−1.055***	−2.49	−0.752***	−2.43	−1.268***	−4.42	BVPS*LOSS	+	0.873	0.54	0.376	0.86	0.329	0.65
CH_E*LOSS	−	−0.462	−1.33	−0.315	−1.25	−0.214	−0.97	EPS*LOSS	−	−5.204	−1.21	−6.113**	−2.31	−0.383	−0.19
LOSS	−	−0.042	−0.57	0.049	0.78	−0.075	−1.18	LOSS	−	−2.447	−0.77	0.044	0.02	−1.680	−1.06
Avg. VIF		10.99		26.9		14.0		Avg. VIF		30.26		14.41		13.4	
Max. VIF		109.58		300.6		171.76		Max. VIF		341.78		132.2		156.6	
No. of obs.		1325		1210		1666		No. of obs.		1325		1210		1666	
No. of clusters		649		645		595		No. of clusters		649		645		595	
Adj. R^2		0.08		0.49		0.19		Adj. R^2		0.66		0.82		0.80	

All regressions are controlled for industry and year effects and error terms are clustered at firm level.
One tailed for coefficients with predicted signs, and two tailed otherwise.
* Denotes significance level at 10%.
** Denotes significance level at 5%.
*** Denotes significance level at 1%.

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4.3. Additional analysis of confounding effects of 2008 financial crisis

To test the robustness of our results in different time periods, we rerun Eqs. (3) and (4) without the three-way interaction terms on our sample firms in the post-IFRS era over three sub-periods: pre-, amid, and post-financial crisis. Table 8 shows that the main effect of R&D expenses is insignificant after convergence in the return model. Although the main effect of R&D expenses is insignificant in the return model, the interaction effects between R&D expenses and national investor protection strength and uncertainty avoidance are significant during the financial crisis at the 1% and 10% level, respectively. On the other hand, the main effect of R&D expenses is significant amid and after the financial crisis in the price model. In addition, the national investor protection strength and level of uncertainty avoidance consistently and significantly play a role in the market valuations of R&D expenses in the post-IFRS era (all at the 1% level). In the post-financial crisis period, national financial reporting culture shows marginal influence in the value relevance of R&D expenses. The findings support the notion that the value relevance of R&D expenses changes over time, conditional on the role of national institutional factors.

In sum, our results suggest critical roles of national institutional factors in the market valuation of R&D expenses, which are conditional on various R&D accounting treatments. Specifically, we find that the strength of investor protection and the level of uncertainty avoidance consistently play a role in the market valuation of R&D expenses. The importance of the strength of investor protection and the level of uncertainty avoidance persist even after the convergence to IFRS in the case of market valuations of R&D expenses. The implication for standard setters and countries contemplating convergence to IFRS is that institutional factors across countries are critical in the harmonization of accounting standards.

5. Conclusion

The adoption of IFRS is assumed to improve accounting quality. However, empirical research has shown that IFRS adoption is associated with positive, zero, or negative capital market outcome (De George et al., 2015; ICAEW, 2015). A great number of prior studies have examined the overall effect of IFRS on the change of the association between prices/returns and aggregate earnings but do not incorporate the nature of the differences between IFRS and the preceding national GAAP into assessment (ICAEW, 2015). We take a new approach to studying the changes in the value relevance of accounting information after IFRS adoption by focusing on one accounting item: R&D expenses. We compare the economic value of R&D expenses under IFRS with that under previous national GAAP. We argue that changes in the value relevance of R&D expenses after IFRS adoption depend on preceding national GAAP.

Consistent with our predictions, we find that markets switching from the mandatory expensing or optional capitalization rule to IFRS experience declines in the value relevance of R&D expenses because capitalization of R&D expenditures with future economic benefits is required under IFRS. Furthermore, we find that the way markets value reported R&D expenses remains moderated after the IFRS adoption by the three national institutional factors examined in this study. The specific effects of the national institutions on R&D value relevance hinge on the previous national GAAP before convergence. Specifically, with a switch from the mandatory expensing or capitalization rule to IFRS, markets with stronger investor protection experience greater changes in the value relevance of R&D expenses. On the other hand, with a switch from the optional capitalization rule to IFRS, markets with higher uncertainty avoidance experience smaller changes in the value relevance of R&D expenses. Our study provides evidence that institutional factors play a significant role in the value relevance of accounting information and highlight the importance of institutional arrangements in shaping the economic consequences of convergence in financial reporting. This finding is consistent with the conclusions in Leuz (2003).

Our findings should be interpreted with caveats. One limitation is that we do not have data on capitalized R&D assets although we controlled for the effect by including the book value of equity in the price model. Therefore, it is difficult to make strong inferences regarding how different accounting treatments of R&D improve the information content of both the income statement and the balance sheet. Another issue is that we currently take accounting standards as exogenous, whereas they can be endogenous. In other words, legal structures and institutional factors can affect accounting standards (Ball et al., 2000; Soderstrom & Sun, 2007). Future study can address the endogeneity issue.

Appendix A. Variable definitions.

Return–earnings relation variables	
RET_{it}	Annual stock returns starting from the fourth month after the fiscal year-end t − 1 to the end of the third month after the fiscal year-end t, adjusted for dividends at year t.
E_{it}	Income before extraordinary items and R&D expenses for fiscal year t scaled by the beginning market value of equity.
CH_E_{it}	Change in income before extraordinary items and R&D expenses between fiscal year t − 1 and t, scaled by the market value of equity at the fiscal year-end t − 1.
RD_{it}	R&D expenses for fiscal year t, scaled by the beginning market value of equity.
Price–book value–earnings relation variables	
P_{it}	The stock price at the end of the fourth month after the fiscal year-end t (translated to US dollars using the spot exchange rate).
$BVPS_{it}$	Book value of equity per share at fiscal year-end t (translated to US dollars using the spot exchange rate).
EPS_{it}	Income before extraordinary items and R&D expenses per share for fiscal year t (translated to US dollars using the average exchange rate over the fiscal year).
$RDPS_{it}$	R&D expenses per share for fiscal year t (translated to US dollar using the average exchange rate over the fiscal year).
Firm characteristics	
$LOSS_{it}$	An indicator variable that equals one if a firm's income before extraordinary items for fiscal year t is negative, zero otherwise.
$SIZE_{it}$	Firm size measured as the natural logarithm of total assets at the fiscal year-end t (total assets are translated to US dollars using the spot exchange rate).
Accounting treatment and national institutional factor variables	
GAAP1	An indicator variable that equals one if a firm adopts an accounting treatment that requires mandatory expensing of research and development costs, zero otherwise. Specifically, firms in Germany that adopt domestic accounting standards or firms that adopt the US GAAP or accounting standards consistent with the US GAAP.
GAAP2	An indicator variable that equals one if a firm adopts an accounting treatment that allows optional capitalization of development costs if certain conditions are met, zero otherwise. Specifically, firms in Finland, France, the Netherlands, Norway, Sweden, Switzerland, and the UK that adopt domestic accounting standards.
GAAP3	An indicator variable that equals one if a firm adopts an accounting treatment that requires mandatory capitalization of development costs if certain conditions are met, zero otherwise. Specifically, firms in Australia that adopt domestic accounting standards.
FinRepCul	Average financial reporting culture score at the national level. Leuz et al. (2003) propose four dimensions of earnings management: (1) the smoothing of reported operating earnings using accruals, (2) the correlation between changes in accounting accruals and operating cash flows, (3) the magnitude of accruals, and (4) small loss avoidance (refer to Leuz et al. (2003) for detailed construction). Countries are ranked for each of the four earnings management dimensions in an order that a higher rank suggests that reported earnings are less subject to management manipulation at the national level. The national financial reporting culture score for each country is the average of the four rankings. We have a total of 24 countries for rankings to preserve more variations in our measure for

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Appendix A (*continued*)

	financial reporting culture at the country level. The 24 countries are Australia, Austria, Belgium, Denmark, Finland, France, Germany, Hong Kong, India, Italy, Japan, Malaysia, the Netherlands, Norway, Pakistan, Philippines, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, and the UK.
InvProStrength	The product of the strictness of insider trading law and the natural logarithm of the number of years passed since the first enforcement of insider trading laws for each country in fiscal year t. The strictness of insider trading law considers the scope, sanction and private right, covering five individual components. We assign one point for each individual component if present and the strictness of insider trading law is then the sum of points received under these five individual components. Scope measures the breadth of the insider trading prohibition and covers two individual components. First, if corporate insiders are prohibited from tipping outsiders (tippees) about material nonpublic information and/or encouraging them to trade on such information for personal gain, this individual component receives one point. Second, if tippees are prohibited from trading on material nonpublic information that they have received from corporate insiders, this individual component receives another point. Sanction measures the expected criminal and monetary sanctions for violating a country's insider trading laws and covers two individual components as well. First, if the monetary penalty for violating insider trading laws is potentially greater than the insiders' trading profits, this component receives one point. Second, if violation of insider trading laws is a potential criminal offense, this component also receives one point. Private right receives one point if private parties have a private right of action against parties who have violated the country's insider trading laws (Source: Beny, 2005; Durnev & Nain, 2007).
UAI	Uncertainty avoidance index, one of the six dimensions of national culture developed by Hofstede et al. (2010), measures how the members of a society feel about uncertainty and ambiguity. A higher index indicates that the members of a society are more uncomfortable about and intolerant of uncertainty and ambiguity. The index ranges from zero to 100.

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Please cite this article as: Gong, J.J., & Wang, S.I.-L., Changes in the value relevance of research and development expenses after IFRS adoption, *Advances in Accounting, incorporating Advances in International Accounting* (2016), http://dx.doi.org/10.1016/j.adiac.2016.05.002