Erasmus University Rotterdam
Erasmus School of Economics
Department of Business Economics
Accounting, Auditing and Control

Value relevance of R&D expenditures amongst the cash-expense and the successful-efforts method

Master's thesis Accounting, Auditing and Control FEM11112

Author: **Sophie A. Westerik 428417**
Supervisor: **Drs. R. van der Wal, RA**
Co-reader: **Prof. dr. D. Veenman**
Date: **June 13, 2016**

Abstract

This thesis investigates whether there is a difference in value relevance perceived by the users of the financial statements amongst expensing (cash-expense method) and capitalization (successful-efforts method) of R&D expenditures. More specifically, the difference in value relevance of R&D reporting in the US and the UK from the period of 2006 to 2016 is assessed using the Ohlson (1995)-model. In the US full expensing of R&D expenditures is required, whereas in the UK it is required to recognize intangible assets under certain recognition criteria. The results of this research indicate that there is positive value relevance under both the cash-expense and the successful-efforts method regarding R&D accounting in the US and the UK. Furthermore, the results also show a higher level of value relevance regarding R&D capitalization in the UK than expensing in the US. The overall finding of this research is that value relevance perceived by the users of financial statements is higher under R&D capitalization than under R&D expensing for the sample period of 2006 to 2016.

Key words: Research & Development; Value relevance; Capitalization; Expensing; United States; United Kingdom; Ohlson (1995)-model

JEL Classification: C33, M38, M41, O30, O38

List of Abbreviations

Alternative Investment Market	AIM
Earnings	E
Feltham-Ohlson	F-O
Financial Accounting Standards Board	FASB
Fixed Effects	FE
International Accounting Standards	IAS
International Accounting Standards Board	IASB
Market Value	MV
Random Effects	RE
Research & Development	R&D
Research & Development expenditures (variable)	RD
Size dummy variable regarding R&D	RDsize
High-technology sector dummy variable regarding R&D	RDHT
Statement of Financial Accounting Standards	SFAS
Total Assets	TA
UK	United Kingdom
US	United States

Table of Contents

Abstract		2
List of Abbreviations		3
1.	Introduction	7
1.1	General Introduction and Research Objective	7
1.2	Research Motivation	11
1.3	Thesis Outline	12
2.	Theoretical Framework	13
2.1	Financial Statement Informativeness	13
2.2	Value Relevance Studies	15
2.3	Conservatism	15
2.4	Cash-expense vs. Successful-efforts Method	16
3.	Development of Hypotheses	19
3.1 Value Relevance and R&D Research		19
3.2 R&D Capitalization vs. Expensing		21
3.3 Control Variables: Firm Size and High-Technology Sector		23
4.	Research Methodology	26
4.1	Research Design	26
4.2	Value Relevance of R&D Expenditures	27
4.3	Sample	29
4.3.1	Cross-Country Comparison	29
4.3.2	Selecting the Sample	30
5.	Empirical Findings	32
5.1	Data Preparation and Descriptive Statistics	32
5.1.1	Log-Linear Values	32
5.1.2	Hausman Test	32
5.1.3	Heteroscedasticity and Multicollinearity	33
5.1.4	Descriptive Statistics	35
5.2	Regression Analysis and Results	36
6.	Robustness Check	38

6.1 Total Assets as a Measure for Firm Size 38
6.2 Data Preparation and Descriptive Statistics 39
6.2.1 Log-Linear Values 39
6.2.2 Hausman Test 39
6.2.3 Heteroscedasticity and Multicollinearity 39
6.2.4 Descriptive Statistics 40
6.3 Robustness Check Results and Analysis 41
6.4 Summary Robustness Check 42
7. Discussion 43
7.1 Internal Validity 43
7.2 External Validity 43
7.3 Comparing the Results with Prior Empirical Findings 44
7.4 Caveats to this Study 46
8. Summary and Conclusion 48
References 50
Appendix A Literature Review 54
Table 7. *Literature Overview* 54
Appendix B Sample 57
Table 8. *Description of Variables* 57
Table 9. *Industries Included in the High-Technology Sample* 58
Appendix C Regression Analysis 59
Fig. 2. *Histograms of Variables –US sample* 59
Fig. 3. *Histograms of Variables – UK Sample* 60
Table 10. *Hausman Test* 61
Table 11. *Breusch-Pagan Heteroscedasticity Test* 61
Table 12. *Pearson Correlation Matrix – US sample* 62
Table 13. *Pearson Correlation Matrix – UK sample* 62
Table 14. *VIF Test* 63
Appendix D Robustness Check 64
Fig 4. *Histograms of Variables Robustness Check – US Sample* 64
Fig. 5. *Histograms of Variables Robustness Check – UK Sample* 65

Table 15. *Hausman Test – Robustness Check* 66
Table 16. *Breusch-Pagan Heteroscedasticity Test – Robustness Check* 66
Table 17. *Pearson Correlation Matrix– US sample – Robustness Check* 67
Table 18. *Pearson Correlation Matrix – UK sample – Robustness Check* 67
Table 19. *VIF Test – Robustness Check* 68

1. Introduction

1.1 General Introduction and Research Objective

Throughout recent history, the discussion on how to account for Research & Development (R&D) projects, which are mostly likely to generate future benefits, has been ongoing. The Financial Accounting Standards Board (FASB) introduced *Statement of Financial Accounting Standard (SFAS) No. 2: Accounting for Research and Development Costs* in the United States by October 1974, which requires companies in the United States (US) to fully expense their R&D outlay. Next to the requirement to fully expense R&D costs in the period they incur, it also requires disclosure of the amount of R&D in the financial statements of the company. *SFAS No. 2* still applies in the US to date. The FASB, as a proponent of expensing R&D outlays, argues that expensing of R&D outlays eliminates management's opportunities to capitalize R&D projects with low success probabilities and thereby reduces the chances of earnings management regarding R&D expenditures. Proponents this conservative way of accounting find that the expensing of R&D costs increases financial statements' objectivity (FASB, 1974). On the other hand the International Accounting Standards Board (IASB), as an opponent of R&D expensing, argues that R&D projects are one of the economically most important assets for a company and that if accounting does not recognize these costs seriously as assets that it reduces the relevance and credibility of financial reporting (IAS Plus, 2016; Healy, Myers and Howe, 2002). Opposing to *SFAS No. 2*, *IAS 38* prescribed the following two recognition criteria:

1. *"It is probable that the future economic benefits that are attributable to the asset will flow to the entity; and*
2. *The cost of the asset can be measured reliably"*

These two recognition criteria apply both for externally acquired as well as for internally generated (e.g. R&D) intangible assets.

The debate on whether R&D expenditures should be expensed or capitalized is not just a question on the application of accounting procedures; this choice has direct consequences in valuation and profitability calculations of the entity. Under *SFAS No. 2*, firms in the US need to expense R&D costs in the income statement. Whereas considering *IAS 38*, firms in the United Kingdom (UK) for example need to capitalize development stages of the process on their income statement. When R&D expenditures are capitalized, the balance sheet shows a higher amount of assets which enhances the entity's value. On the other hand, R&D investments are often based on trial-and-error research, under which a considerable amount of non-successful projects exist(Cerqueti, Marazzina and Ventura, 2016). When an entity engages in R&D spending, it faces a high degree of uncertainty in terms of which projects are viable and which are not.

Even during the development phase a vast majority of the projects appear unviable (Cerqueti *et al.*, 2016). Basically, there are two prescribed methods regarding the accounting treatment of R&D, these are the *cash-expense method*, whereby all outlays are expensed when incurred, and the *successful-efforts method*, whereby parts of the R&D project are capitalized (Healy *et al.*, 2002).

In particular, this difference in accounting treatment of R&D expenditures and the value relevance of the financial statements as a consequence is the main topic of interest in this research. Considering R&D-intensive firms, it is interesting to see how users of the financial statements interpret the different accounting treatments, and whether it actually has consequences for perceived firm value. It is found that under the application of *SFAS No. 2* there is consistent evidence that investors and analysts are typically misled, since earnings are understated as a consequence of the accounting treatment (Lev, Sarath and Sougiannis, 2004; Chambers, Jennings and Thompson, 2002; Penman and Zhang, 2002). On the contrary, the application of *IAS 38* is associated with both higher analysts' forecast errors and forecast dispersions. This implies that with capitalization of R&D expenditures information in the financial statements, forecasting and valuation of the company becomes more complex which would hamper financial analysts and investors to get a true and fair view of the firm's financial situation (Dinh, Eierle, Schultze and Steeger, 2015). While there are several researches focusing on the economic importance of R&D or either one of the two ways of disclosing R&D, there still is a lack of concise research on whether expensing or capitalizing R&D is more value relevant for the users of the financial statements. This research will therefore analyze the following research question:

Is there a difference in perceived firm value regarding R&D capitalization vs. expensing in the financial statements?

This research question assimilates accounting treatments with respect to R&D expenditures. Market value of the firm will be the proxy measure of perceived firm value in this research. In order to assess whether perceived firm value increases, deteriorates or remains the same under R&D capitalization versus expensing, several sub-questions need to be considered. These sub-questions are deemed useful in building conclusions that are of use in the process of getting to the answer of the research question as stated above. In order for empirical research on accounting choice to be value adding to the existing literature, the research first needs to determine the nature of the implications of the research (Fields, Lys and Vincent, 2001). Therefore, the first sub-question that comes to mind is:

Why and for whom is this research useful?

This question will be answered and elaborated on in section 1.2 *Research Motivation.* This particular section describes the several parties for whom this research is deemed interesting as well as why this research is unique with respect to other researches. With this in mind, the research focuses on all firms currently active in the market in the United States and the United Kingdom in order to distinguish between the two different accounting treatments of R&D: expensing vs. capitalization. In order to assess these different accounting treatments regarding R&D expenditures, a clear and concise view on this topic is needed, which leads to the second sub-question being:

What academic theory is important for the hypothesis development of this research?

The answer to this second question is important in order to develop sound hypotheses which will be the foundation in assessing the research question. This question will be answered throughout Chapter 2. Assessing prior academic literature is fundamental to this research and therefore empirical R&D accounting choice studies with special emphasis on distinction between R&D expensing (cash-expense method) and R&D capitalization (successful-efforts method). Furthermore, it is important to keep other factors in mind that could possibly influence the results. These factors can be controlled for by including them in the experiment as control variables. Control variables are not of primary interest to the experiment itself. They are of influence on experimental results and are kept constant throughout the experiment in order to test the association between the dependent and independent variables. Considering this, the third and fourth questions are as follows:

What are the findings of available empirical research regarding R&D value relevance research?

What are important factors that need to be controlled for regarding R&D value relevance research?

These two sub-questions are addressed in Chapter 3. Chapter 3 gives a thorough review of available relevant empirical literature as well as a presentation of the research hypotheses developed based on these findings. Section 3.3 provides an explanation on the chosen control variables. An overview of the answers to these questions can also be found in Table 7, Appendix A. Following the hypotheses, the research needs to be constructed. Therefore a methodology and sample has to be chosen. This leads to the fifth sub-question being:

What research design and what sample is most appropriate for this research?

This question will be elaborated on in Chapter 4, where the Ohlson (1995)-model and the US and UK sample are discussed. Furthermore, an explanation will be given on the choice of cross-country comparison applied in this research. Once the research design is established and explained, data and regression analysis will be of importance, which leads to the following sub-question:

What are the regression results?

Chapter 5 elaborates on the statistical tests applied and the regressed model, discussing the results of this research. The results indicate that R&D expenditures significantly have a more positive influence on market value of the firm under the successful-efforts method than under the cash-expense method. Taking into consideration the robustness of these results leads to the sixth sub-question:

Are these results robust?

Chapter 6 is dedicated to this sub-question, which explains the robustness tests and the results of these tests. The robustness tests executed imply that the results found are sound and robust, showing similar variable coefficients as well as significance levels, compared to the main regression model. Lastly, the seventh sub-question is:

What are the implications of these results? How do they relate to results from prior empirical literature and the research hypotheses?

This last sub-question will be answered in Chapter 7, Discussion. This chapter describes the internal as well as the external validity of this research. Furthermore, it compares the results found in this research to the results from previous empirical literature. Lastly, the caveats to this study are described in this chapter. By finding an answer to all these sub-questions, the research question can be assessed and answered and a sound conclusion can be made.

The results of this research indicate there is value relevance amongst both the successful-efforts method and the cash expense-method, where value relevance is found to be more positive when the successful-efforts method is applied. Moreover, perceived firm value by the users of the financial statements is higher amongst R&D capitalization than expensing.

1.2 Research Motivation

This section will address the motivation for the research, answering the first sub-question:

Why and for whom is this research useful?

Since this research focuses on the value relevance of financial statements towards its users, it will be relevant for both users and preparers of the financial statements. Disclosure rules and accounting measurement techniques typically influence real decisions made by users of the financial statements (Kanodia and Sapra, 2016). Consistently, information about corporate profitability will impact decision making of investors in the capital markets. Therefore, this research will be of interest for users of the financial statements. For corporate management, as the preparers of the financial statements, the outcomes of this research are also relevant since for them it is interesting to see whether and how the accounting for R&D leads to real decisions made by the public. For management it is attractive to present the public with sanguine financial results. In their survey research, Graham, Harvey and Rajgopal (2005) even report that a vast majority (80%) of the survey participants would decrease discretionary spending on R&D, advertising and maintenance in order to meet an earnings target. Additionally, 55% of the survey participants state that in order to meet earnings targets, they would delay starting a new project. These findings indicate the tension between short- and long-term targets of the firm. With regard to those outcomes, the behavior of management regarding accounting for R&D is also influenced by the effect on real decisions made by financial statement users.

Moreover, Fields, Lys and Vincent (2001) argue that fundamental questions on whether, under what circumstances and how accounting choice matters should be addressed in accounting research. These fundamental questions have some difficulties since every accounting choice often faces more than one effect, which are often hard to measure. This thesis addresses such a fundamental accounting question and will therefore also be useful for standard setters as well as academics. Furthermore, it is interesting for standard setters to see how users of the financial statements value the firm regarding R&D capitalization vs. expensing. This research uses a cross-country comparison in countries with similar capital markets in order to assess the market's reaction regarding the treatment of accounting for R&D. Most R&D and value relevance researches conducted so far focus at the country level, which diminishes the external validity of the findings (Leuz and Wysocki, 2016). Moreover, this study focuses on the regulations associated with R&D accounting whereas the vast majority of academic literature is often based on mandatory and voluntary disclosure studies whereby the firm's practices gathers more attention than regulation. Therefore, this research is based on a cross-country comparison based on two distinct samples: a US based

sample regarding R&D expensing and a UK based sample regarding R&D capitalization. Furthermore, the UK and the US face similar capital markets as well as the same (common) law system (Oswald and Zarowin,2007), which enhances the generalizability and comparability of the results of this research. Comparing these two countries allows for drawing direct inferences regarding the different accounting policies.

1.3 Thesis Outline

The remainder of this thesis is organized as follows. Chapter 2 provides the necessary academic theory and support in order to get a proper understanding of the topic. Chapter 3 discusses relevant empirical literature and results in order to develop the research hypotheses, which will support finding an answer to the research question. Subsequently, Chapter 4 elaborates on the Ohlson (1995)-model applied in this research in order to assess the hypotheses. Chapter 5 provides sample information as well as descriptive statistics as well and the regression results. Chapter 6 provides a robustness check on the test results, indicating robust results of the regression analysis discussed in Chapter 5. Subsequently, Chapter 7 discusses the implications of this research by discussing internal as well as external validity of the results and comparing this research outcomes with related empirical literature. This thesis concludes with Chapter 8 which provides a summary and conclusion of this research.

2. Theoretical Framework

In this chapter attention is paid to relevant academic theory and literature which is deemed important in order to develop the hypotheses and research design of the study. Therefore, this Chapter answers the second sub-question:

What academic theory is important for the hypothesis development of this research?

As an answer to this question, four topics regarding academic theory relevant for this research are covered, these are financial statement informativeness, value relevance, conservatism and the cash-expense and successful-efforts method. In section 2.1, informativeness of financial statements will be discussed. Hereafter, in section 2.2, attention is paid to the concept of value relevance. This topic is followed by a brief explanation on conservatism in section 2.3, and subsequently the chapter concludes with an explanation on the cash-expense and successful-efforts method in section 2.4.

2.1 Financial Statement Informativeness

Investments in R&D projects are classified as intellectual capital investments. Intellectual capital projects are perceived as the main creators of value for several types of firms and economic sectors. It is proven that these types of investments exceed financial as well as physical capital (Corrado and Hulten, 2010). Nevertheless, despite the economic importance for firms as well as for the economy and the growth in intellectual capital investments over the recent years, the recognition of these type of projects in the financial statements is inconspicuous (Maaloul and Zéghal, 2015). Especially under expensing of R&D expenditures, which is prescribed by the FASB in the US, the recognition of intangible assets as a result of R&D is being hampered. The application of this conservative accounting treatment leads to serious biases in the accounting matching principle, where periodically costs and revenues are matched. It is shown that this non-recognition of intellectual capital, amongst which R&D projects, causes serious impairment in the value-relevance of financial information, which explains market value (Maaloul and Zéghal, 2015; Core, Guay and Buskirk, 2003; Lev and Zarowin, 1999). As a result, inefficiencies may occur in the resource allocation process on financial markets as well as inefficiencies to the society in general. It is shown that these inefficiencies provoke information asymmetry between a firm's in- and outsiders (Aboody and Lev, 2000). Typical examples are misevaluation of companies' future earnings, share illiquidity and an increased cost of capital (Maaloul and Zéghal, 2015). In order to prevent or avoid inefficiencies resulting

from intellectual capital investments several accounting, financial and economic standard-setter bodies have taken initiatives in order to promote the information quality provided to external users (EC, 2011; OECD, 2006; SEC, 2003; FASB, 2001). This convergence project between these standard-setter bodies resulted in the advancement of guidelines and frameworks having the objective to encourage management to voluntary disclose intellectual capital investment information as an adjective outside the financial statements. This way, the information asymmetry between in- and outside parties and resulting inefficiencies would be offset.

Despite the fact that an amount of studies theoretically and descriptively prescribed management to voluntarily disclose this intellectual capital information to their financial statements, the amount of research that relates to the validation of this view up and until today is scarce(Maaloul and Zéghal, 2015; Zéghal and Maaloul, 2011; Skinner, 2008). Further to that, the amount of research available finds evidence that the financial statement informativeness of high-tech firms is significantly lower than in low-tech companies (Maaloul and Zéghal, 2015). High-tech companies consistently invest more in intellectual capital, and especially in R&D investments. Therefore, the current applied method of expensing R&D expenditures in the US, which prohibits capitalization of intangible assets, likely distorts the financial statement informativeness of companies that invest in intellectual capital heavily.

These outcomes relate to the semi-strong form efficient market hypothesis. The semi-strong form efficiency is a class of the efficient market hypothesis which entails that all public available information is calculated into a stock's current share price (Malkiel and Fama, 1970). Only not-public available information can be beneficial for investors seeking abnormal returns on investments, all other information is accounted for in the stock prices. However, if under conservative accounting treatment of value-enhancing R&D projects the informativeness of the financial statements deteriorates this information might not be fully reflected in the share prices. Moreover, Fields *et al.* (2001) argue that in general there is mixed evidence on the existence of market efficiency; most researchers neither find evidence of market inefficiency nor do they find unambiguous evidence that they are efficient. Therefore, there are some difficulties on drawing strong inferences between accounting choices and asset pricing. This phenomenon might be described by Bloomfield's (2002) incomplete revelation hypothesis. This hypothesis states that when data or statistics are more costly to collect from public data, these are not completely reflected in market prices. Bloomfield argues that this association is caused because statistics that are more costly to extract from public information drive less interest for traders. Subsequently, these statistics are less completely revealed by market prices (Bloomfield, 2002).

2.2 Value Relevance Studies

Typically, value relevance studies investigate the association between financial statement information and share returns and prices and evaluate the relevance of the financial statement information. Value relevance studies are captured within the broad field called market-based accounting research. Within this field of research there are two perspectives on decision usefulness, these are the *information perspective* and the *measurement perspective* (Scott, 2012). The information perspective assumes that equity markets are efficient and are also known as information content studies. This stream of literature assumes that investors obtain new, useful information from financial statements whereby they revise their expectations of future firm performance which eventually leads to buy/sell decisions. Thereby, security prices and share returns depends on the usefulness of information (Scott, 2012). However, under the measurement perspective research focuses on decision usefulness of the financial statements, also known as value relevance research. This perspective does not assume fully efficient security markets and makes greater usage of fair values, which implies there is a larger role for financial statements predicting the firm's fundamental value. Under this perspective, share prices represent a benchmark measure of the firm's performance (Scott, 2012). Research questions in this field of academics typically involve questions regarding how well accounting information captures information that is relevant to users of the financial statements (Barth, Beaver and Landsman, 2001). The design of this research is mostly used to assess whether accounting numbers in the financial statements reflect the information used by users of the financial statements, which also applies to this research. Mainly, the association between the accounting numbers and recognition in equity values (stock returns and prices) are explored in this field of research. Since this thesis investigates the difference in value relevance regarding R&D capitalization versus expensing it can be categorized as market-based accounting research regarding the measurement perspective.

2.3 Conservatism

Value relevance studies can accommodate the consequences of accounting conservatism. Ruch and Taylor (2015) give the following conceptual definition: *"Accounting conservatism can be defined as accounting policies or tendencies that result in the downward bias of accounting net asset value relative to economic net asset value"*. Other well-known definitions of conservatism are Bliss's (1924): *"Anticipate no profit, but anticipate all losses"* and Watts's (2003): *"The accountant's tendency to require a higher degree of verification to recognize good news as gains than to recognize bad news as losses"*. As a consequence, the application of the concept of conservatism on accounting numbers is that there is an asymmetrical

treatment of gains and losses in the financial statements and usually results in a persistent understatement of net asset values.

As a matter of fact, conservatism is one of the most fundamental concepts in accounting. The typical debate encompassed by academic literature and standard setters is how costly or beneficial conservatism actually is to the users of the financial statements (Watts, 2003). One side of the debate encompasses the Financial Accounting Standard Board's (FASB) opinion which contends that conservatism generates biases in accounting information and compromises the neutrality of the financial statements, which will eventually result in inefficient decision-making by financial statement users (Watts, 2003). On the contrary, it is argued that conservatism is something which arises naturally between contracting parties and argue that conservatism is a necessity which functions as an efficient contracting mechanism (Watts and Zimmerman, 1983). With respect to this thesis, less focus will be on conservatism. The focus will be more on how financial statement information relates to the market value of the firm than on prudence, which typically encompasses the focus in conservatism research. This type of value relevance studies can be applied in analyzing the implications and analyzing the association between accounting numbers and the value of equity. Consequently, research in value relevance functions as a foundation for the constitution of financial accounting practices which are perceived conservative by financial statement users (Barth *et al.*, 2001). Whereas the focus lies more on the value relevance aspect, the classical discussion still rests whether a conservative, prudent treatment or a true and fair view of the financial numbers is more decision-useful for the financial statement users.

2.4 Cash-expense vs. Successful-efforts Method

Considering R&D capitalization and expensing in the financial statements (regarding the recognition of intangible assets), three accounting methods can be distinguished: the cash-expense method, full-cost method and the successful-efforts method (Healy *et al.*, 2002). Under the cash-expense method, all outlays are expensed when they incur. This expensing of R&D is in line with the FASB's view on accounting for R&D intangibles and is commonly applied regarding R&D spending under US General Accepted Accounting Principles (GAAP) in the United States. Second, there's the full-cost method under which the asset is recognized immediately after product discovery. Subsequently, the asset is amortized over its expected useful life. It is written down when the asset becomes impaired. The full-cost method serves more as a theoretical model, generally this model is not used in practice (Healy *et al.*, 2002). Third, under the successful-efforts method for R&D accounting, R&D spending is capitalized after initial product discovery,

and amortizes the costs of the successful product over its expected lifetime. In case the product is deemed unsuccessful, the capitalized value of the asset is written down off the balance sheet. This method follows the prescribed standard by the International Financial Accounting Standards Board (IASB) under IAS 38 regarding R&D outlays, where research costs need to be expensed and development costs capitalized after commercial as well as technical feasibility of the asset has been established (IAS Plus, 2016). Given these points, the emphasis in this thesis will be on the cash-expense method and the successful-efforts method as theoretical models for expensing and capitalizing R&D expenditures.

One of the main arguments in favor of the cash-expense method is the verifiability of the financial statements. Expensing R&D outlays diminishes the chances and opportunities for management to engage in earnings management by means of capitalizing low-success projects (Healy *et al.*, 2002). Further to this, litigation is key to conservatism in the recent past. It leads to asymmetric payoffs in a sense that overstating a firm's net assets is more likely to generate litigation costs than when the firm understates its net assets. In case of asset understatement, the firm's expected litigation costs are reduced. This asymmetry is associated with managers attaining to opportunistic payments to themselves and other parties to the firm. Therefore, this explanation advocates constraints regarding opportunistic payments to managers (Watts, 2003). Regarding R&D spending, expensing will avoid overstatement of net assets which reduces the opportunity of litigation. Therefore, in order to avert litigation risks it is best to expense R&D spending via the profit and loss account according to the proponents of the cash-expense method. All in all, arguments in favor of expensing R&D outlays are most often justified by the principle of conservatism (Lev *et al.*, 2005).

By way of contrast, IAS 38 requires intangible assets meeting the relevant recognition criteria to be measured at cost initially and subsequently be amortized over their useful lifetime. The recognition criteria under IAS 38 prescribe that the intangible asset must be probable to generate future economic benefits which will flow to the entity and that the cost of the asset can be measured reliably, whereas these criteria apply whenever the intangible is acquired externally or generated internally (IAS Plus, 2016). More specifically, regarding R&D costs IAS 38.54 and 38.57 prescribe the following: *"Charge all research costs to expense. Development costs are capitalized only after technical and commercial feasibility of the asset for sale or use have been established. This means that the entity must intend and be able to complete the intangible asset and either use it or sell it and be able to demonstrate how the asset will generate future economic benefits"*.
This way of intangibles measurement is in line with the above-described successful-efforts method. Capitalization of R&D outlays is shown to enable information provision towards the users of the financial statements through better matching of costs and benefits in R&D. It is argued that expensing of R&D has

an adverse effect on the level of informativeness of financial statements (Lev and Zarowin, 1999). Informativeness of financial statements is defined as the financial statements information being useful or relevant to the user and thereby being able to influence difference in decisions made by the user of the financial statements (Zéghal and Maaloul, 2015). Furthermore, under the successful-efforts method management has reporting discretion on what information they disclose. This implies that they can use their own judgment in providing inside information within their financial statements (Oswald, 2008; Healy *et al.*, 2002).

3. Development of Hypotheses

In this chapter, results from prior academic literature regarding R&D spending and the informativeness and value relevance of the financial statements will be discussed, thereby answering the third sub-question:

What are the findings of available empirical research regarding R&D value relevance research?

The main focus of this chapter will be on the research design used in previous literature as well as the results of these researches. Furthermore, attention will be paid to control factors of this research, answering the fourth sub-question:

What are important factors that need to be controlled for regarding R&D value relevance research?

This chapter is fundamental to both the development of the hypotheses and research design. Section 3.1 portrays R&D value relevance studies, whereas in section 3.2 the focus is on empirical literature regarding whether to capitalize or expense the R&D expenditures. A summary overview of all literature discussed in this chapter can be found in Table 7, Appendix A.

3.1 Value Relevance and R&D Research

In the first section of this paragraph, capital market based accounting research regarding value relevance and R&D outlays in the US is discussed, followed by European (UK) based literature as a counterpart.

Lev and Sougiannis (1996) address the issues of objectivity, reliability and value-relevance of the FASB regarding R&D capitalization. As discussed in paragraph 2.4, the FASB supports the cash-expense method in accounting for R&D outlays since they are concerned about the verifiability of the accounting numbers and engagement of managers in earnings management in case of capitalization of (parts of) the R&D project. Their sample is based on US firm data from the COMPUSTAT R&D master file between 1975 and 1991 and their research is conducted using a Fama-French (1992) style research approach. Lev and Sougiannis (1996) first estimated the relation between R&D expenditures and subsequent earnings, which

allowed to compute firm-specific R&D capital and amortization rates as well as a measurement for periodic amortization. Subsequently, reported earnings and book values were adjusted for R&D capitalization. The results indicate that these adjusted-for-capitalization values of R&D are associated with share prices and share returns. According to the authors this is an indication of the value-relevance of capitalization of the R&D process towards investors. Furthermore, Lev and Sougiannis (1996) show evidence on the association between R&D capital and subsequent stock returns. The estimated capital in R&D is not fully reflected in the share prices of a firm. This finding is attributed by the authors to either underreaction to R&D information by the market or to a market risk factor that is associated with R&D capital.

Chan, Lakonishok and Sougiannis (2001) find that share returns do not differ between firms with or without R&D. Despite their research outcomes, they say that R&D still might influence financial performance of the entity beyond average share returns. The authors argue that there is a lack of accounting disclosure on R&D which implies that investors are less than fully informed. In their sample, Chan *et al*. (2001) use all listed firms on the New York Stock Exchange (NYSE), National Association of Securities Dealers Automated Quotations (NASDAQ) and the American Stock Exchange (AMEX) using data available on COMPUSTAT and firms who are engaged in R&D spending. Their research methodology is based on the one used by Lev and Sougiannis (1996), where Chan *et al*. (2001) estimate the proportion of past spending on R&D that is still prolific in certain years. Their research results do not indicate a direct association between R&D outlays and future share returns, whereas the timespan tested for is three years. The authors attribute this finding to the prescribed cash-expense method for R&D accounting prescribed by the FASB.

Further to this, Tsoligkas and Tsalavoutas (2011) conducted a research on value relevance of R&D accounting treatment in the UK following the implementation of IFRS. Under UK GAAP, capitalization of certain R&D expenditures is permitted, which is in line with the in paragraph 2.4 described successful-efforts method. Their sample consists of firms with R&D activity according to the UK R&D Scoreboard, where all non-listed firms and firms that are listed in the Alternative Investment Market (AIM) are excluded. Financial data is retrieved from DataStream and directly from the companies' annual reports. In order to test for the value relevance of accounting information, a theoretical extension of the fundamental Ohlson (1995)-model is used. In this model, market value of a firm can be expressed as a linear function of its book value of equity and net income. The outcomes of this research show that accounting numbers in the UK have a strong association with share prices. Further to that, the authors find that capitalized R&D assets are positively value relevant. Basically, the outcomes of this research demonstrate that investors perceive capitalized R&D assets as assets with probable future economic benefits.

In their paper, Shah, Liang and Akbar (2013) examine the value relevance of R&D outlays pre- and post-IFRS implementation in the UK. Further to that, the authors examine whether firm size and sector differences are of influence on the value relevance of R&D accounting information during their sample period. The sample is based on UK listed firms involving R&D activity during the period between 2001 and 2011. Hence, a 4 year period before, and a 7 year period after IFRS implementation where data is retrieved from DataStream. Here, again, the Ohlson (1995) valuation framework is applied as a benchmark model. The authors find that there is a positive value relevance of capitalized R&D and no value relevance of expensed R&D. They argue that investors perceive capitalized R&D related to successful R&D projects which in turn will generate future economic benefits. Furthermore, significant differences in R&D capitalization and value relevance between small and large firms were found, where capitalization of R&D in large firms appears more value relevant.

Overall, Lev and Sougiannis (1996) conclude that capitalization leads to positive value relevance towards investors. Furthermore, Chan *et al*. (2001) find that higher R&D capital intensity generates higher stock returns where they calculated firm-specific capital and amortization rates themselves for their sample where the cash-expense method applies. They do however state that they did not find a direct link between R&D expenses and stock returns. Nevertheless, their outcomes likewise serve as an indicator of R&D informativeness in the financial statements where expensing of R&D is less value relevant than R&D capitalization. Moreover, Tsoligkas and Tsalavoutas (2011) as well as Shah *et al*. (2013) conclude that there is a positive value relevance regarding capitalized R&D. The results of these above summarized researches, leads to the following research hypothesis, stated in the alternative form:

H1: *R&D expenditures (capitalized or expensed) are value relevant in the financial statements.*

3.2 R&D Capitalization vs. Expensing

The previous paragraph describes that according to the research of Chan *et al.* (2001) there is a lack of disclosure on R&D under the cash-expense method, which implies investors to be less than fully informed. Moreover, the authors attribute the fact that they did not find a significant direct association between R&D expenditures and future stare returns to the by the FASB prescribed cash-expense method under SFAS *no. 2*. Furthermore, Lev and Sougiannis (1996) also explain the misappropriation of R&D expenditures by stating that R&D expenditures are not fully reflected in share prices under the current accounting treatment SFAS *no. 2* in the US

In their research, Lev and Zarowin (1999) investigate the usefulness of financial information towards investors and compare this with total information in the market place. The sample of this research exists of all available US firms on Compustat from 1976-1996. Their results indicate a deterioration of financial information usefulness over recent history. They argue that innovative investments, such as R&D expenditures, are expensed immediately whereas the benefits are recorded in a later stage which leads to matching problems. The authors argue that the present system fails most seriously in the accounting for intangibles in reflecting enterprise performance and value due to these mismatching of costs and benefits. Furthermore, the authors assert that expensing of R&D has an adverse effect on the level of informativeness of financial statements.

In line with the research of Lev and Zarowin (1999), Oswald and Zarowin (2007) examine whether R&D capitalization leads to more informative stock prices relative to expensing R&D. Their sample consists of all UK firms available on DataStream that disclosed either an R&D asset or R&D expenditures for the years 1990-1999. Informativeness is measured as a coefficient on future earnings, which is reflected in current period share returns versus current and future earnings. The authors stress that the decision to capitalize or expense R&D is endogenous and therefore control for self-selection bias is needed. The main findings of this article show that capitalization of R&D expenditures results in more market information. Thus, share prices are more informative under the successful-efforts method following this research.

Likewise, Healy *et al*. (2002) develop a simulation model in their research in order to procure evidence regarding the tradeoff between relevance and objectivity in accounting for R&D outlays. This research focuses on the pharmaceutical industry since this industry is heavily dependent on R&D success and well-documented since the industry is under supervision of strong regulatory overview. The model, using 500 firms over 32 years, the authors generate is used in order to determine the association between the successful-efforts method and the cash-expense method and how these accounting methods relate accounting data and economic firm values. The results of their research show that the successful-efforts method of accounting for R&D is more highly correlated to economic returns of the firm than applying the cash-expense or the full-cost method in R&D accounting for firms in the pharmaceutical industry.

Recently, the article of Ciftci and Zhou (2016) was published, where the researchers investigated how value-relevance of financial information for intangible-intensive firms can be enhanced by investigating two alternatives: capitalizing R&D expenditures or disclosure on intangible information. The authors used patent counts/citations in order to proxy for intangible intensity and found that the value relevance of disclosing intangible information (patent counts/citations) next to the application of the cash-expense

method is more value-relevant than R&D capitalization for the sample part with a high level of patents. For the medium- and low-patent groups which comprise less successful innovations, it is found that R&D capitalization (successful-efforts method) is more value-relevant than the disclosure

In summary, the above described researches in this paragraph conclude that financial statement information is more decision useful (Lev and Zarowin, 1999) and more value-relevant (Oswald and Zarowin, 2007; Healy *et al*, 2002) under the successful-efforts than under the cash-expense method. Only the recently published research outcomes of Ciftci and Zhou (2016) are somewhat contradicting since the authors find that value relevance is not higher under the successful-efforts method regarding high-patent firms. However, for the medium- and low-patent group the authors also find that R&D capitalization is more value-relevant than disclosing. Furthermore, this study addresses jointly the discussion on whether to capitalize or expense R&D outlays as well as comparing between R&D capitalization and disclosure of patent information (Ciftci and Zhou, 2016). Considering the outcomes of the above-described researches, the second hypothesis of this research, stated in the alternative form, is:

H2: *R&D expenditures are more value relevant under the successful-efforts method than under the cash-expense method.*

3.3 Control Variables: Firm Size and High-Technology Sector

In order to assess the association between value relevance and R&D accounting policy, control variables are added to the experiment. Control variables are variables that are kept constant throughout the experiment in order to clarify the association between the dependent and the independent variable. This part of the chapter will investigate previous academic literature regarding characteristics which are likely to be of influence to the association.

Another point controversy in academic literature is whether capitalized R&D is more value relevant across different firm sizes. It is argued that large firms typically invest more and therefore capitalize more R&D expenditures whereas these firms also have size-advantages regarding valuation implications (Pindado, De Queiroz and De La Torre, 2010; Connolly and Hirschey, 2005). On the other hand, it is found that small firms capitalize more R&D costs, which in turn are deemed more value relevant by the authors (Cazavan-Jeny and Jeanjean, 2006; Hirschey and Spencer, 1992). The first studies that investigated a correlation between R&D market valuation and firm size found a positive relationship, also known as support for the Schumpeterian hypothesis (Cohen and Klepper, 1996).

The paper of Pindado *et al*. (2010) investigates how firm characteristics influence market valuation of R&D expenditures. Basically, their research focuses on how firm characteristics moderate the association between firm value and R&D spending. Their research takes size, firm growth, free cash flow, market share, external finance dependence as well as capital and labor intensity into account for Eurozone countries. Their results indicate that several firm characteristics moderate firm value and R&D outlays. Most specifically, firm size exerts a positive effect due to economies of scale effects, R&D cost spreading and higher accessibility to capital markets. Whereas the effect of firm size is the strongest, the authors also found moderating effects of firm growth, free cash flow and market share are found.

Additionally, Connolly and Hirschey (2005) investigate valuation consequences of R&D investments by firms different of size using Tobin's *q* ratio. The researchers used an US sample, where data was retrieved from COMPUSTAT (which implies that only R&D expensers are taken into account for this sample). The findings represent differences in effectiveness of R&D expenditures among different firm sizes. The authors find that a dollar of R&D spending is more effective regarding firm value under large than smaller firms. The authors attribute their findings to economies of scale effects, geographic scope effects and superior financial resources.

In their research, Cazavan-Jeny and Jeanjean (2006) assessed value relevance of R&D reporting in France, where both R&D capitalization and expensing are allowed. Opposing similar researches, the authors find a less positive value relevance under R&D capitalization opposed to expensing. Furthermore, the outcomes indicate that firms which choose to capitalize successful R&D projects are smaller. Their results, however, may not be highly generalizable since their focus is on the French capital market but are in line with those of Hirschey and Spencer (1992).

Hirschey and Spencer (1992) investigate the effects of size on market valuation of fundamental factors. The authors divided the sample in three firm-size groups: small, medium and large, where firm-size is based on the market value. They find that amongst size classes there is a striking difference regarding the relevance of R&D expenditures to market valuation. Hirschey and Spencer (1992) find that there is no consistent difference between market valuation of R&D expenditures for small and medium-sized firms. Moreover, in 10 out of 16 periods, market valuation of R&D is larger for medium than for large firms. Their (alternative) hypothesis that firm-size effects are superior to large firms is supported in no instance. Note however, that this research focuses only on the market valuation of R&D expenditures and does not distinguish between expensing or capitalization of R&D.

Summarizing, previous academic literature shows mixed findings on the effect of firm size regarding value relevance of R&D expenditures. In the researches of Pindado *et al*. (2010) and Connolly and Hirschey (2005) the findings indicate a positive association between value relevance of R&D expenditures and firm size. Conversely, Cazavan-Jeny and Jeanjean (2006) and Hirschey and Spencer (1992) found that this was not the case. In order to control for the effect of firm-size on value relevance, a control variable on large firm size is added to the regression model.

Next to firm size, whether the firm operates in the high-tech industry is also an important influential factor. It is found in previous studies (Maaloul and Zéghal, 2015; Sonnier, 2008) that the industry in which the firm operates influences financial statement informativeness. Maaloul and Zéghal (2015) find that the financial statement informativeness of high-tech companies is significantly lower than that of low-tech companies. Moreover, the authors argue that high-tech firms have higher investments in intellectual capital which does not show on their financial statements due to the current accounting standards in the US regarding intangible assets. Therefore, a distortion will occur in the financial statement informativeness of firms heavily investing in intellectual capital (Maaloul and Zéghal, 2015).

Moreover, Sonnier (2008) compared the levels of intellectual capital disclosure in the US and found that high-technology firms typically disclose more on their intellectual capital. He states that, in line with Lev and Zarowin (1999), the value relevance of the financial statements and other accounting information has deteriorated over time, especially for high-tech firms. Therefore, the second control variable added to the experiment will be regarding the high-technology sector.

4. Research Methodology

This chapter discusses the research methodology applied in this empirical association study, thereby answering the fifth sub-question:

What research design and what sample is most appropriate for this research?

Section 4.1 explains the choice for the Ohlson (1995)-model, whereas section 4.2 elaborates on the specific model and variables chosen and explains how this model is used in order to test for the two research hypotheses as described in Chapter 3. Furthermore, section 4.3 elaborates on the sample, where a thorough explanation is given for the cross-country comparison as well as a description and explanation of the data cleaning process.

4.1 Research Design

In order for accounting numbers to be deemed value relevant, significant association with equity market values is needed (Beaver, 2002). Basically, value relevance studies combine valuation theory with contextual accounting arguments and thereby allow for prediction of how accounting numbers relate to the market value of equity. Regarding valuation theory, three types of valuation models can be distinguished. First, there is the earnings-only approach, whereby Miller and Modigliani portray the value of equity as the present value of permanent future earnings (Beaver, 2002). Second, there is the balance-sheet approach which is applied in the researches of Barth *et al. (1996), Barth (1991) and Landsman (1986).* Under this approach, also referred to as the capital maintenance approach, the main emphasis is on the change in shareholders equity in order to determine net income during the period. Third, Feltham-Ohlson (F-O) modeling represents a firm's value as a linear function of the book value of equity and present value of the expected future abnormal earnings (Beaver, 2002). Next to valuation, contextual accounting arguments are incorporated in order to predict association between market values of equity and accounting numbers. This implies that execution of value-relevance studies requires understanding of institutional information on the way how financial statements are prepared as well as contextual arguments on the properties of measurement methods (Beaver, 2002).

Following prior research (Ciftci and Zhou, 2016; Shah *et al*., 2013; Tsoligkas and Tsalavoutas, 2011; Shah, Stark and Akbar, 2009, 2008; Oswald, 2008, Shortridge, 2004) regarding value relevance of accounting information, the value relevance of accounting information in the financial statements is assessed using the F-O modeling. Whereas capital market research typically is primarily empirical, F-O modeling combines theory with empirical work. It contends value of equity in terms of accounting numbers, which relies on the present value of expected dividends (Beaver, 2002).

4.2 Value Relevance of R&D Expenditures

Models used in previous literature(Ciftci and Zhou, 2016; Shah *et al*., 2013; Tsoligkas and Tsalavoutas, 2011; Shah, Stark and Akbar, 2009, 2008; Oswald, 2008) are predominantly based on the Ohlson (1995) and the Feltham and Ohlson (1995) valuation framework. The Ohlson (1995) benchmark model framework appears as follows:

$$MV_{it} = \alpha_0 + \alpha_1 E_{it} + \alpha_2 BV_{it} + \varepsilon_{it} \quad (1)$$

Where MV_{it} represents the market value of firm *i* in time period *t*. MV_{it} is measured three months after the end of the fiscal year for each firm *i*. This three month after year-end measurement rests on the assumption that after this time period, the impact of the newly released information in the market is incorporated in the market value for the following period (Shah *et al*, 2013). Furthermore, E_{it} represents the earnings of firm *i* in time period *t*, whereas BVE_{it} stands for the book value of equity of firm *i* in time period *t*. Lastly, the error term (ε_{it}) represents the residual. In order to test for value relevance under both capitalization and expensing of R&D outlays, the following hypothesis will thus be assessed:

H1: *R&D expenditures (capitalized or expensed) are value relevant in the financial statements.*

Following prior academic literature within this area (Tsoligkas and Tsalavoutas, 2011; Oswald, 2008; Shah *et al*., 2008) the Ohlson (1995)-model will be applied in order to assess the value relevance of R&D expenditures. Furthermore, control variables on firm size and high-technology sector are added. This addition of the control variables leads to the following model:

$$MV_{it} = \beta_0 + \beta_1 E_{it} + \beta_2 BVE_{it} + \beta_3 RD_{it} + \beta_4 RDsize + \beta_5 RDHT + \varepsilon_{it} \quad (2)$$

Where E_{it} stands for earnings of firm *i* in period *t*. BVE_{it} represents the book value of equity of firm *i* in period *t*. Moreover, RD_{it} represents the annual amount R&D expenditures for firm *i*. Furthermore, *RDsize* and *RDHT* are the slope-dummy control variables representing firm size and High-technology sectors respectively. Firm size is measured by median market value of equity, whereas high-technology sectors are classified according to SIC codes; an overview of the SIC codes determining whether the firm belongs to the high-tech sector can be found in Table 9, Appendix B. This equation will be estimated for both sample countries (UK and US). It is out of the scope of this research to estimate one single regression incorporating both sample countries due to the different currencies amongst those countries and different exchange rates amongst the panel data set. Accordingly, (2) represents a measurement of overall effects of R&D expenditures to market value during the sample years. If, for example, the market perceives R&D expenditures as related to future economic benefits, then β_3 will be positive. Likewise, if the market perceives the R&D expenditures negatively, β_3 will be negative.

In order to test whether R&D expensing vs. capitalization enhances value relevance, the second research hypothesis will be evaluated:

H2: *R&D expenditures are more value relevant under the successful-efforts method than under the cash-expense method.*

Model (2) also allows to test whether there is a significant difference in value relevance regarding R&D expenditures between the successful-efforts and the cash-expense method. In order to assess this hypothesis, the coefficient on *RD* will be compared between the US (cash-expense method) and the UK (successful-efforts method). A higher coefficient (β_3) implies that the applied accounting method is perceived more value relevant. Fig. 1 visualizes how the research model relates to the assessments of the research question by presenting Libby Boxes.

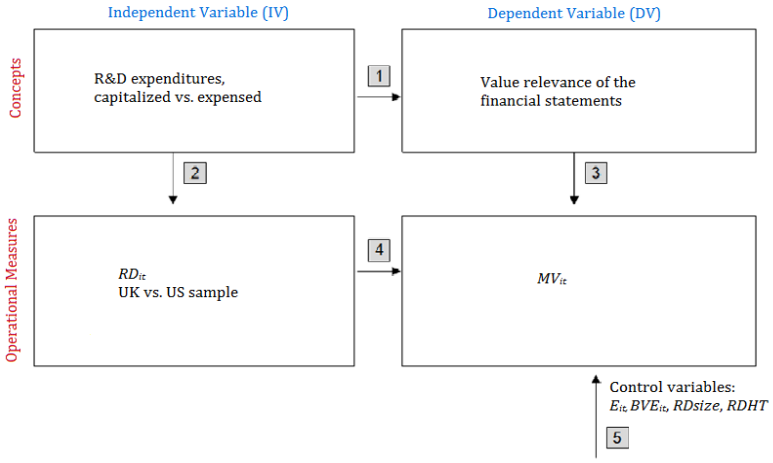


Fig. 1 - Libby Boxes

4.3 Sample

In this section, the sample will be discussed. First, an explanation will be given on the choice to compare US with UK data, subsequently there will be elaborated on the variables and how and from where these are derived. This section will conclude with a part on the sample selection and data cleaning process.

4.3.1 Cross-Country Comparison

The majority of empirical literature regarding value relevance of R&D expenditures focuses on the situation in the US (Maaloul and Zéghal, 2015). However, despite high level of development and the worldwide importance of the US capital market, the US is relatively unique with regard to their accounting standard *SFAS No. 2* under which all R&D expenditures must be expensed. Even more, almost all other industrialized countries face policies that allow for (selective) capitalization of R&D expenditures (Zhao, 2002). A more practical approach would involve cross-country comparison of value relevance regarding R&D expenditures. Such an international comparison however is likely to be complicated by other factors than the differences in accounting standards. This study investigates the difference in value relevance of R&D reporting in the US and the UK. As described in Chapter 1, the US requires full expensing of R&D expenditures whereas in the UK it is required to recognize intangible assets if the recognition criteria are met. The comparison between US and UK data allows for drawing direct inferences regarding the applied accounting policy. Most previous studies focus, as mentioned above, only on one country whereby the researchers compare the (simulated) value relevance of capitalized vs. expensed R&D expenditures for a single set of firms. (Maaloul and Zéghal, 2015; Shah *et al*., 2013, 2009; Oswald, 2008; Healy *et al*., 2002). Further to that, the UK has a well-developed liquid capital market which is similar to that of the US (Oswald and Zarowin, 2007). Both the UK and the US adopt to a common law system. A typical characteristic of common law countries is that they face diffuse equity ownership, higher quality of accounting earnings and a greater financial transparency in comparison with code-law countries. Hence, the application of the same law system in both countries results in capital market similarities, which enhances the generalizability of this research. Furthermore, as discussed in section 4.2, it is out of the scope of this research to estimate a single regression model incorporating US and UK data due to currency differences. Both the US and the UK sample consist of panel data, containing ten unique years over which the firm-year observations of the panel are distributed. Moreover, not every firm faces the same year-end date. Assessing one single regression would imply that the currencies of either one of the two sample sets would need to

be converted for every unique firm and year-end date for every year which is outside the scope of this research. Therefore, two distinct regressions are estimated and compared with each other.

4.3.2 Selecting the Sample

The initial sample is based on all listed US and UK companies active in the market involving R&D activity over the 10-year period between 2006 and 2016. The sample period starts after the implementation of IFRS in order to assure uniform accounting reporting standards. The entire US dataset is retrieved from Compustat North-America, whereas the UK dataset is retrieved from Compustat Global, except for market value data of the UK which was available on DataStream.

Companies belonging to the SIC 6 code (insurance, banks and real estate companies) are eliminated from the sample due to the different accounting rules applied in these industries. By eliminating these companies from the sample, homogenous accounting principles apply to the sample. In addition, firms with missing data on R&D expenditures, book value of equity, market value and earnings are removed, as well as firms with non-positive R&D expenditures. Furthermore, firms with negative book value of equity are also eliminated from the sample. The latter is associated with uncertain future performance as well as that negative book value of equity will result in biased data analysis. Furthermore, market value, earnings, book value of equity and R&D data is winsorized at the 1st and 99th percentile in order to prevent regression results to be biased from effects of extreme outliers.

In order to control for the firm size and high technology effects, slope dummy variables are generated. This allows for a change in slope by including in the model additional independent variables that are equal to the product of an indicator variable and a continuous variable. Slope dummy variables, instead of intercept dummy variables thus do not influence the intercept of the regression, but rather influence the slope. For the firm size and high-tech sector the dummy's on these two factors are multiplied by R&D as follows:

1. The sample need to be distinguished on firm size. As a benchmark for size, companies' median market value of equity is taken, whereas the reference is the latest year of examination. Using these numbers, the sample is subdivided in large and small firms constructing the slope-dummy variable *RDsize* by multiplying the size indicator dummy with R&D.
2. In order to distinguish between the high-tech and low-tech companies the sample is divided between these two groups by classification on SIC codes. The high-technology sample includes firms in the pharmaceutical, electronics, computer and telecommunications industries. The

specific SIC codes on which the high-tech sample is based can be found in Table 9, Appendix B. Also here, a slope-dummy variable on the high-tech sector, *RDHT*, is created by multiplying the high-tech indicator dummy with R&D.

5. Empirical Findings

In this chapter, attention will be paid to the necessary statistical tests and the analysis of the regression results. Herewith, the sixth sub-question will be answered, namely:

What are the regression results?

In order to answer this sub-question, first a deeper understanding of the statistical analysis is needed. Section 5.1 Data Preparation & Descriptive Statistics will elaborate on this. Subsequently, the analysis of the results will be provided in section 5.2 Regression Analysis.

5.1 Data Preparation and Descriptive Statistics

5.1.1 Log-Linear Values

After data cleaning (see *4.3.2 Selecting the Sample*) and before estimating the model, proper data preparation is needed. The first step here is to check the assumption of normal distribution of the data amongst the variables. Due to the exclusion of negative values for *MV*, *E*, *BVE* and *RD*, normality appeared not to be the case for both the US and the UK sample sets. In order to overcome this problem, natural logarithm values of these variables are taken which results in normal distribution of the variables. Moreover, taking natural logarithm values of the variables overcomes size and scale effects by ensuring the data is normally distributed. Histograms of all variables before and after the treatment of natural logarithm values as well as histograms of the regression residuals can be found in Figure 2 for the US sample and Figure 3 for the UK sample, Appendix C.

5.1.2 Hausman Test

Second, the model type had to be chosen. Panel data is used in this research, since both the US and the UK sample contain observations of different firms over multiple time periods. Two techniques for estimating panel data are the fixed effects and the random effects model. The fixed effects (FE) model

explores the association between predictor and outcome variables within an entity. Two important assumptions of the FE model are:

1. Something within the panel individual can have impact on the predictor or outcome variables, which needs to be controlled for.
2. These time-invariant characteristics are unique to the individual and should not be correlated with other individual characteristics.

Secondly, the random effects (RE) model assumes that the variation across entities of the panel is assumed to be random and uncorrelated with the independent variables of the model. That is to say, explanatory variables are considered to arise from random causes. In order to test for whether to apply the FE or RE model, the Hausman test is executed. Under the Hausman test the null hypothesis is that the RE model is the preferred model, which is tested against the alternative hypothesis of the FE model being the preferred model. In effect, the Hausman test tests whether the unique estimation errors are correlated with the regressors. With a P-value of 0.000 for both the US and the UK dataset the null-hypothesis of the Hausman test is soundly rejected, which implies that the panel data of this research has to be estimated using the FE model. Test results can be found in Table 10, Appendix C.

5.1.3 Heteroscedasticity and Multicollinearity

In order for the regression results to be unbiased, they may not suffer from serious statistical problems such as heteroscedasticity and multicollinearity. The Breusch-Pagan test is executed in order to test for heteroscedasticity. This test assumes a null hypothesis of no heteroscedasticity, whereas the alternative hypothesis states that heteroscedasticity is the case. With a P-value of 0.000 for both countries' datasets, the null hypothesis is rejected and thereby heteroscedasticity is found amongst the standard deviations of the variables in the model of both datasets. In order to overcome the problem of heteroscedastic standard errors, robust standard errors are applied to the model. Breusch-Pagan test results can be found in Table 11, Appendix C.

Second, there needs to be tested for multicollinearity amongst the variables. If multicollinearity is the case, then two or more variables in the model show a (nearly) perfect linear correlation with each other. One way to check for multicollinearity is to examine the Pearson correlation table. The Pearson correlation table represents the correlation between all the variables individually. The Pearson correlation tables for

both the US and the UK datasets can be found in Table 12 and Table 13, Appendix C and show significance at the 5%-level for all variables regarding both the US and the UK sample. Furthermore, in order to test whether the model suffers from multicollinearity a VIF test is applied. This VIF test is applied to both samples' datasets in order to test whether multicollinearity amongst the variables affects the estimated model. Test-output with VIF values between 5 and 10 indicate high correlation which may be problematic. If the VIF is >10, then the regression coefficients are poorly estimated due to the problem of multicollinearity and this problem requires serious further investigation. For both datasets, mean VIF values smaller than 5 were found, which implies the estimated model does not suffer problematically from the problem of multicollinearity. The VIF test outcomes can be found in Table 14, Appendix C. This table shows that for the UK sample, individual VIF values of *E* and *BVE* are between the range of 5 and 10 and therefore these variables are highly correlated with other variables. However, since these variables are widely applied in previous research in the Ohlson (1995)-model and because the mean VIF value of the entire model is below 5, the multicollinearity of these two variables in this particular sample can be safely ignored.

5.1.4 Descriptive Statistics

Table 1 and Table 2 report the descriptive statistics for both the US and the UK sample. The US sample consists of 2311 firm-year observations, whereas the UK sample consists of 1326 firm-year observations after data preparation and data cleaning. This considerable difference in the number firm-year observations can be attributed to the fact that the US has a larger capital market than the UK. Furthermore, it can be seen that the values of the descriptive statistics are somewhat comparable to each other, especially with regard to the R&D expenditures. The US reports a mean log-value of 2.310 on this variable, whereas the UK sample shows a mean log-value of 2.113. Furthermore, some slightly negative values are generated due to the log-natural transformation, which can be seen under the "Min." column. All descriptive statistics presented in the tables represent natural logarithm values of the prepared data of the variables.

Table 1. *Descriptive Statistics – US sample*

Descriptive Statistics of the US sample during 2006-2016					
Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
MV	2311	6.402	1.987	0.871	10.839
E	2311	3.615	2.221	-6.908	8.486
BVE	2311	5.533	1.811	-0.937	9.943
RD	2311	2.624	2.113	-3.576	7.352
RDsize	2311	1.122	2.142	-0.511	7.352
RDHT	2311	1.259	1.970	-2.919	7.352

All descriptive statistics presented here represent the natural logarithm values of the variables.

Table 2. *Descriptive Statistics – UK Sample*

Descriptive Statistics of the UK sample during 2006-2016					
Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
MV	1326	5.126	2.302	0.307	11.004
E	1326	2.681	2.455	-5.809	9.105
BVE	1326	4.447	2.077	-0.247	10.695
RD	1326	0.961	2.130	-4.343	6.919
RDsize	1326	0.601	1.503	-2.303	6.919
RDHT	1326	0.222	1.152	-4.343	6.838

All descriptive statistics presented here represent the natural logarithm values of the variables.

5.2 Regression Analysis and Results

In this section, the empirical regression results as presented in Table 3 will be discussed. Model (2) is used in order to estimate the regressions for both the US and the UK sample from 2006 to 2016. For both samples, the regression models are significant under the F-test at the 1%-level. The adjusted R^2 of the US sample is 0.414, whereas the adjusted R^2 of the UK sample is 0.407. This indicates that the explanatory power of both regression models is rather equal.

Table 3. *Regression Results*

Value Relevance of R&D expenditures for the US and UK sample (2006-2016)				
	US sample		***UK sample***	
Variable	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*
Constant	***3.223	15.32	***1.497	4.14
E	***0.206	9.04	***0.175	4.77
BVE	***0.382	8.44	***0.676	7.65
RD	*0.072	1.71	***0.134	2.67
RDsize	***0.137	12.15	**0.053	2.45
RDHT	-0.020	-0.24	-0.034	-0.51
	Observations	2311	*Observations*	1326
	Adj./Pseudo R^2	0.414	*Adj./Pseudo R^2*	0.407
	F	***128.31	*F*	***43.10

*, ** and *** denotes significance at the 10%, 5% and 1%-level respectively.
T-statistics are based on heteroscedasticity consistent Huber-White standard error estimates.

For the US sample of the period 2006 to 2016, the coefficient on R&D expenditures is positively and significantly (at the 10%-level) related to market value with a coefficient of 0.072. This result indicates that for the US there is positive value relevance regarding R&D expenditures during the sample period. Furthermore, for the US regression the coefficients on the intercept, *E*, *BVE*, and *RDsize* are all positive and highly significant, at the 1%-level. This implies these variables also show a positive association with market value. The coefficient on *RDHT* is negative as well as insignificant, which implies no important conclusions can be drawn on this variable.

For the UK sample of the period 2006 to 2016, the coefficient on R&D expenditures is positively significant at the 1%-level. This implies R&D expenditures are positively related to market value. The positive coefficient of 0.134 indicates that also in the UK there is a positive value relevance regarding R&D expenditures during the sample period. Correspondingly, this regression result show positive coefficients for *E*, *BVE* and *RDsize* which are all significant at the 1%-level. This implies that these variables also show

a positive association with market value of the firm. Just as for the US sample, the coefficient of *RDHT* is insignificant, allowing for no conclusions to be drawn on this variable.

Comparing the regression results of both samples, all variables except *RDHT* show significant results. Furthermore, the *RD* variable of the US sample is the only significant result which does not show significance at the 1%-level. The result of the coefficient *RD* variable of both samples shows that in the UK there is a considerably higher association between R&D expenditures and market value of the firm perceived by the users of the financial statements. It is also worth mentioning that in the UK sample the coefficient *BVE* is nearly twice as big as the same coefficient in the US sample. Next to this, the coefficient on *RDsize* is considerably larger in the US sample.

To summarize, the regression results show positive as well as significant coefficient regarding R&D expenditures, implying that under both the cash-expense and the successful-efforts method there is positive value relevance regarding R&D expenditures. Herewith, the first research hypothesis is supported. Moreover, the nearly twice as high coefficient of *RD* in the UK sample compared to the coefficient of *RD* in the US sample implies that the perceived value relevance of R&D expenditures is higher under the successful-efforts method (applied in the UK) than under the cash-expense method (applied in the US). This result supports the second hypothesis, which states that perceived value relevance of R&D expenditures is higher under the successful-efforts than under the cash-expense method. Herewith, the answer to the research question is demonstrated by the results which provide evidence that users of the financial statements perceive higher value relevance regarding capitalized R&D expenditures than expensed R&D expenditures.

6. Robustness Check

This chapter is an extension on Chapter 5 "Empirical Findings", as it presents robustness checks as an additional analysis to the presented results in Chapter 5. Moreover, this chapter provides an answer to the seventh sub-question, namely:

Are these results robust?

Robust test results can be defined as results that are able to reproduce the same test outcome in a different setting or under different circumstances. This can be seen as a measure of the capacity of the results to remain unaffected by variations in parameters of the research method. Generally, robust test results indicate generalizability as well as reliability of the found results (van der Heyden, Smeyers-Verbeke and Massart, 2006). In order to assess the robustness of the empirical findings as described in Chapter 5, the regression analysis will be reproduced, only now with total assets (*TA*) as a measure of firm size, replacing market value of equity.

First, section 6.1 provides a description on the choice of total assets as a measure for firm size used in the robustness check. Subsequently, section 6.2 provides statistical test results as well as descriptive statistics for the US and UK samples where total assets is used as a measure of firm size. Lastly, section 6.3 presents results regarding this robustness check.

6.1 Total Assets as a Measure for Firm Size

In this research, market value of equity is used as a measure of firm size in the regression model. This is a widely used proxy for firm size in accounting literature (Shah et al., 2013, 2009, 2008; Tsoligkas and Tsalavoutas, 2011). In order to assess the robustness of the test results, market value of equity is being replaced by total assets as a proxy for firm size in order to execute the robustness checks. Total assets is also a generally applied proxy measure of firm size (Cazavan-Jeny and Jeanjean, 2006; Pindado et al., 2001). Particularly, the natural logarithm of total assets (TA_{it}) will be used as a firm size proxy in the regression model of the robustness check.

6.2 Data Preparation and Descriptive Statistics

In order to perform the robustness check, data had to be prepared and statistically analyzed in the same way as described in Chapter 5. This implies that the data had to be tested on normality, a Hausman test had to be performed, in order to decide which panel estimation technique should be used, and heteroscedasticity as well as multicollinearity tests had to be performed.

6.2.1 Log-Linear Values

Due to the exclusion of negative values for *MV*, *E*, *BVE*, *RD* and *TA*, data is not normally distributed and therefore natural logarithm values of all these variables are applied in order to overcome size and scale effects. Histograms of the variable Total Assets before and after treatment of natural logarithm values and the regression residuals can be found in Figure 4 for the US sample and Figure 5 for the UK sample, Appendix D.

6.2.2 Hausman Test

In order to test whether the fixed effects or random effects model needs to be applied, the Hausman test is executed regarding the robustness check. Test results can be found in Table 15, Appendix D. Also here, the null-hypothesis of applying the random effects model is soundly rejected with P-values of 0.000 for both sample sets. Therefore, FE estimation technique is applied to the regression of the robustness check.

6.2.3 Heteroscedasticity and Multicollinearity

To test for heteroscedasticity, the Breusch-Pagan test was executed on the robustness check samples. A P-value of 0.000 was found for both the US and the UK sample whereby in both cases the null-hypothesis was rejected and heteroscedasticity is assumed to be present. The Breusch-Pagan test results can be found in Table 16, Appendix D.

Also the robustness check multicollinearity tests were executed. The Pearson correlation matrices are presented in Table 17 and Table 18, Appendix D. Also a VIF test was executed of which the test-results can

be found in Table 19, Appendix D. Also here, the mean VIF values found for both data sets are below 5, which implies the regression model does not suffer significantly from multicollinearity.

6.2.4 Descriptive Statistics

Table 4 and Table 5 report the descriptive statistics for both the US and the UK sample of the robustness check. The US sample consists of 2305 firm-year observations. The difference in firm-year observations between the robustness check US-sample and the normal US sample can be attributed to the merging process of the US dataset with the data on total assets. Furthermore, firm-year observations were lost regarding missing or zero-values of total assets which were deleted from the sample as well. The UK sample for the robustness check consists of 1323 firm-year observations. Here as well, zero and missing value data on total assets are deleted which results in a slightly smaller amount of firm-year observations. All descriptive statistics presented in the tables represent natural logarithm values of the prepared data of the variables.

Table 4. *Descriptive Statistics Robustness Check – US sample*

Descriptive Statistics of the US sample during 2006-2016 – Robustness check					
Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
MV	2305	6.399	1.983	0.871	10.839
E	2305	3.612	2.201	-6.908	8.486
BE	2305	5.532	1.798	-0.937	9.748
RD	2305	2.621	2.107	-3.576	7.338
RDsize	2305	1.503	2.247	-1.575	7.338
RDHT	2305	1.259	1.967	-2.919	7.210

All descriptive statistics presented here represent the natural logarithm values of the variables.

Table 5. *Descriptive Statistics Robustness Check – UK sample*

Descriptive Statistics of the UK sample during 2006-2016 – Robustness check					
Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
MV	1323	5.120	2.295	0.307	11.004
E	1323	2.674	2.448	-5.809	8.973
BVE	1323	4.440	2.069	-0.247	10.695
RD	1323	0.956	2.124	-4.343	6.917
RDsize	1323	0.546	1.443	-2.303	6.917
RDHT	1323	0.222	1.153	-4.343	6.838

All descriptive statistics presented here represent the natural logarithm values of the variables.

6.3 Robustness Check Results and Analysis

The robustness check empirical regression results will be discussed in this section of the paper. Also here, model (2) is applied in order to estimate the regressions for both the US and UK samples. As elaborated on previously in this chapter, the difference with the main regression analysis is that here total assets is taken as a measure for firm size instead of market value of equity.

The regression results of the robustness check with total assets as a measure of firm size are presented in Table 6. For both samples the regressions are significant under the F-test at the 1%-level. The F-statistic tests whether all coefficients in the model are non-zero, which thus is the case for both countries' samples robustness check results. The adjusted R^2 of the US sample is 0.370, whereas the adjusted R^2 of the UK sample is 0.411. This indicates that the explanatory power of the UK regression results are slightly higher than those of the US regression results due to a slightly better fit.

Table 6. *Regression Results Robustness Check*

Value Relevance of R&D expenditures for the US and UK sample (2006-2016), Robustness Check				
	US sample		***UK sample***	
Variable	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*
Constant	***2.929	13.33	***1.476	4.24
E	***0.223	9.26	***0.181	4.84
BVE	***0.437	9.05	***0.691	8.14
RD	*0.078	1.73	***0.178	3.58
RDsize	*0.034	1.86	**-0.115	-2.22
RDHT	-0.007	-0.08	-0.066	-0.99
	Observations	2305	*Observations*	1323
	Adj./Pseudo R^2	0.370	*Adj./Pseudo R^2*	0.411
	F	***72.68	*F*	***44.14

*, ** and *** denotes significance at the 10%, 5% and 1%-level respectively.
T-statistics are based on heteroscedasticity consistent Huber-White standard error estimates.

For the US sample of the period between 2006 and 2016, the coefficient on R&D expenditures is positive and significantly (at the 10%-level) related to market value of equity with a value of 0.078. This result indicates positive value relevance regarding R&D expenditures for the US sample of the robustness check. In fact, the robustness check coefficient on R&D expenditures is 0.006 higher and shows a similar level of significance as the original test results. Furthermore, the US regression results show positive coefficients that are significant at the 1%-level for *E* and *BVE* whereas the coefficient of *RDsize* is positive and significant at the 10%-level, indicating a positive association with market value. The coefficient of *RDHT* is insignificant, implying no conclusions can be drawn on this variable.

For the UK sample of the same period, the coefficient on R&D expenditures reports a value of 0.178 with significance at the 1%-level. This robustness check coefficient is 0.044 higher and shows a similar level of significance as the original regression results. These results imply positive value relevance of R&D expenditures under the successful-efforts method. Correspondingly, the regression results of this robustness check shows positive and significant at the 1%-level results for *E* and *BVE* as well. However, contradicting to the original test results, the coefficient of *RDsize* of the robustness check results is negative with a coefficient of -0.115 and significant at the 10%-level. This robustness check coefficient is 0.168 lower than the *RDsize* coefficient under the original test results, indicating a controversial result. This robustness check test result indicates negative association with market value. Furthermore, the coefficient of *RDHT* is negative as well as insignificant, implying no conclusions can be drawn on this variable.

Comparing the robustness check results of both samples, all variables except *RDHT* show significant coefficients. Furthermore, the coefficient of *RD* is positive as well as significant at the 10%-level for the US sample. This coefficient is also positive, and significant at the 1%-level for the UK sample. These results imply positive value relevance of R&D expenditures in the financial statements for both samples, supporting the first research hypothesis. Furthermore, the *RD* coefficient is 0.1 higher for the UK sample than for the US sample, implying a higher value relevance of R&D expenditures in the UK than in the US. This result supports the second research hypothesis, stating that value relevance of R&D expenditures is higher under the successful-efforts method than under the cash-expense method.

6.4 Summary Robustness Check

To conclude, the robustness check regression results show support for positive value relevance of R&D expenditures as well as higher value relevance of R&D expenditures when they are capitalized relative to expensing .Therewithal, these results indicate that firm value is perceived higher by the users of the financial statements under the successful-efforts method than under the cash-expense method. Moreover, these robustness check results also indicate robustness of the original test results since they show similar as well as significant results.

7. Discussion

In this chapter, the research outcomes of this particular research will be compared with outcomes of related previous empirical researches. Furthermore, caveats of this study as well as internal and external validity of the results will be discussed, providing an answer to the following sub-question:

What are the implications of these results? How do they relate to results from prior empirical literature?

Section 7.1 will discuss the internal validity of this research, whereas section 7.2 will discuss the external validity of the research outcomes. Furthermore, section 7.3 will elaborate on how the research results relate to previous related academic literature. This chapter will be concluded with section 7.4 which describes the caveats to this study.

7.1 Internal Validity

Internal validity reflects the extent to which a causal research outcome can be warranted by a research. In other words, internal validity describes the likeliness that the outcome of the research is observed as a result of the treatment. Since this research is an association study, which tests for the association between R&D expenditures and market value, rather than a causation study, the internal validity of this particular research can be considered relatively low. However, internal validity is mainly important in studies that try to establish a causal relationship. Since this research assesses the difference in association between two distinct accounting treatments rather than trying to establish a causal relationship, the degree of internal validity of this research is also not of particular interest regarding the meaning of the research outcomes. Even so, the lack of internal validity regarding value relevance association studies is criticized by several researches (Barth *et al.*, 2001; Holthausen and Watts, 2001).

7.2 External Validity

External validity reflects on the generalizability of the research outcomes, e.g. it describes the extent to which the research outcomes can be generalized to other situations or settings. External validity can be

assessed in two ways. The first thing that is important regarding external validity is the generalizability of the sample of the research, e.g. does the sample adequately represent the population? Second, proximal similarity is an important quality as well, e.g. would the research outcome be generalizable to other samples and/or populations as well?

Regarding the generalizability of the sample, this research gives quite an adequate proxy for the population. All firms incorporating R&D expenditures are included in both the US and the UK sample and there is only minor elimination of missing data and data with zero-values for market value, book value of equity, earnings and R&D expenditures. Considering proximal similarity, the research outcomes of this research are considered highly generalizable. This research namely assesses all listed firms engaging in R&D in the US and the UK which are considered both as large and influential capital markets located on two distinct continents. Furthermore, since the regression results are proven to be robust by the executed robustness checks, this research also faces a proper degree of transferability of the research outcomes. Accordingly, since this study faces a relatively high generalizability of the sample as well as a high degree of proximal similarity the external validity of this research can be considered relatively high and thus the extent to which the results of this study can be generalized to other situations or people is relatively high.

7.3 Comparing the Results with Prior Empirical Findings

Comparing this particular research with previous researches, the research question as well as methodology of this research is most comparable with the researches of Shah *et al.* (2013), Tsoligkas and Tsalavoutas (2011). Both researches investigate the value relevance of R&D expenditures assess this problem using the Ohlson (1995)-model. A comparison between the results of these research outcomes and this study is made below.

In their research, Shah *et al*. (2013) examine the value relevance of R&D expenditures in pre- and post-IFRS periods in the UK. Using the Ohlson (1995)-model they split up total R&D expenditures into a capitalized and an expensed part. Herewith, the researchers provide separate coefficients for the capitalized part of R&D expenditures and the expensed part of the R&D expenditures for all listed UK firms involving R&D activity. The authors retrieved data regarding capitalized and expensed R&D expenditures from DataStream, of which the sample was driven by a large number of zero's regarding R&D either capitalized or expensed R&D or total R&D expenditures. Furthermore, the authors control for firm size and manufacturing firms. For their post-IFRS sample, which ranges from 2005 to 2011 and is most comparable to this research, the authors find insignificant positive value relevance with a coefficient value of 0.193 for

capitalized R&D. Furthermore, their coefficient on expensed R&D is insignificant, having a negative value of -1.163. The authors compared coefficient differences and hereby claim that capitalized R&D has higher value relevance than expensed R&D and also state that expensed R&D has no positive value relevance and is insignificantly negatively related to market value. Their results are partly in line with the results of this research, since it does approve a higher value relevance regarding capitalization of R&D expenditures, however their findings regarding expensed R&D expenditures differ from the findings of this research. This difference may be attributed to several factors. First, the researchers treated missing reported numbers of R&D as if zero and deliberately describe that their sample is driven by a large number of zero observations. The authors argue that this sample can give a general view on the research question regarding all companies. However, the large number of zero observations may considerably influence the regression analysis, leading to biased results. Furthermore, the authors deflate the data of all their variables by numbers of shares outstanding in order to overcome normality and scale problems. Second, the research of Shah *et al*. (2013) only focuses on capitalized and expensed R&D outlays in the UK and compared those outcomes with each other, whereas this research used US data for R&D expensing and compared these results with UK regression outcome for capitalization of R&D. Next to this, the control variables used in the research of Shah *et al.* (2013) differ from the control variables used in this model. Due to the different approaches applied in this research, the outcomes may also differ. Moreover, there is a considerable difference in the timeframe of the samples used, where Shah *et al.* (2013) their post- IFRS sample ranges from 2005 to 2011 and the sample of this research contains data from 2006 to 2016.

Regarding the research of Tsoligkas and Tsalavoutas (2011), the researchers also applied the Ohlson (1995)-model in order to examine whether the reported R&D assets and expenditures are value relevant in the UK in the post-IFRS period. Their sample consists of UK listed firms with R&D activity from 2006 to 2008. The authors collect financial data from DataStream as well as directly from companies' annual reports. Like Shah *et al*. (2013), the authors divide total R&D expenditures in a capitalized and a expensed part of R&D. Furthermore, the authors used Net Income in their Ohlson (1995)-model where this research and Shah *et al*. (2013) used Earnings. The authors divided their sample into two samples for small and large firms. For the small firms, the authors find positive and significant at the 10%-level results for capitalized R&D whereas for expensed R&D the authors find a negative and insignificant coefficient. For large firms, the authors find a positive coefficient on capitalized R&D and negative coefficient on expensed R&D which are both significant at the 1%-level. The authors conclude, in a similar style as Shah *et al*. (2013), that capitalized R&D has higher value relevance than expensed R&D in the post-IFRS period. This is in line with the findings of this research, except for that Tsoligkas and Tsalavoutas (2011) find negative value relevance for expensed R&D. The difference in results with this research can be attributed to several characteristics. First, the timespan of Tsoligkas and Tsalavoutas (2011) is rather limited, only examining

a timeframe from 2006 to 2008. Second, the same as with Shah *et al*. (2013), Tsoligkas and Tsalavoutas (2011) only focus on a UK dataset in order to compare capitalized and expensed R&D, whereas this research compares two countries' datasets in order to assess the value relevance of R&D expenditures. Furthermore, the authors estimate their regression using pooled ordinary least squares (OLS) estimation, which also explains the relatively high adjusted R^2 of 0.77 the authors found for their model. Inappropriately estimating their regression using pooled OLS without testing for FE or RE models may lead to biased results and diminishes standard errors in the research of Tsoligkas and Tsalavoutas (2011). These smaller standard errors may subsequently lead to an over prediction of the (adjusted) R^2 and misspecification of the model, which is most likely the case in the research of Tsoligkas and Tsalavoutas (2011).

To summarize, the outcomes of this research are partly in line with those of Shah *et al*. (2013) and Tsoligkas and Tsalavoutas (2011). Both researches find positive value relevance for capitalization of R&D expenditures, as well as higher value relevance for capitalization than for expensing of R&D which is in line with the findings of this research. Nevertheless, both Shah *et al*. (2013) and Tsoligkas and Tsalavoutas (2011) find a negative, yet insignificant, value relevance under expensing of the R&D expenditures. This contrasts the main findings of this research since the results indicate significant at the 10%-level and positive value relevance results of expensed R&D. The main difference therewithal can be attributed to the different datasets and timespans over which the regressions were estimated. Furthermore, Shah *et al*. (2013) used a dataset driven by a large number of zero observations, and Tsloligkas and Tsalavoutas applied different estimation techniques than this research, while assessing nearly the same model.

7.4 Caveats to this Study

The results of this research validate an argument on whether to adapt accounting policy that requires mandatory capitalization of R&D expenditures or adapt to the requirement of full expensing of R&D expenditures. Nevertheless, Holthausen and Watts (2001) provide a skeptical view regarding the implications of value relevance research in accounting literature in their paper. Also, Barth *et al*. (2001) argue that value relevance literature provides very little in the way of a theory of accounting and that herewith the contribution to standard setting seems modest. Furthermore, Holthausen and Watts (2001) argue that the Ohlson (1995)-model is a transformation of the discounted dividend model based on the clear surplus relation, which in reality often does not hold. The authors claim that value relevance literature does not seek to develop descriptive theories and therewith it can give little assurance that the inferences drawn by these research outcomes are valid. However, Ko and Lys (2000) argue that while the

Ohlson (1995)-model does not necessarily reflect real-world situations, this is not an adequate reason to abandon the model. The model is not developed in order to be entirely descriptive of the real world. Given the evidence from finance literature that market imperfections matter, the Ohlson (1995)-model represents the base of a branch of research in capital market research, attempting to build a solid foundation rather than providing real-world evidence. Therefore, despite the arguments that some academic papers give regarding the non-usefulness of value relevance research, the results of this study may still be a practical starting point when accounting regulators consider applying certain accounting policies regarding R&D.

8. Summary and Conclusion

This study examines the value relevance of R&D expenditures amongst the cash-expense method and the successful-efforts method from 2006 to 2016. In order to conduct this research, two samples were assessed, a sample of US listed firms engaging in R&D activities (cash-expense method) which contains 2305 firm-year observations, and a sample of UK listed firms engaging in R&D activity (successful-efforts method) which contains 1323 firm-year observations. The value relevance is assessed using the Ohlson (1995)-model, including control variables for firm size and the high-technology sector. The regression results of the two samples are compared in order to make inferences about the value relevance of R&D expenditures amongst the two distinct accounting policies regarding R&D accounting. In addition, a robustness check is carried out in order to validate the results.

The results of this research indicate that there is positive value relevance under both the cash-expense and the successful-efforts method regarding R&D accounting in the US and the UK between 2006 and 2016. This result is significant at the 10%-level for the US sample and shows significance at the 1%-level for the UK sample. Therefore, the first research hypothesis, stating that there is positive value relevance of R&D expenditures amongst both R&D accounting policies, is confirmed. Moreover, the results of this research also show a higher level of value relevance for the UK sample and thereby imply that R&D expenditures are more value relevant under R&D capitalization than under R&D expensing. Herewith, the second research hypothesis, stating that R&D expenditures are more value relevant under the successful-efforts method than under the cash-expense method, is supported. Consequently, the answer provided to the research question is that there is a difference in perceived firm value regarding R&D capitalization vs. expensing in the financial statements. Specifically, this research shows that perceived firm value is higher under R&D capitalization than under R&D expensing.

This study also shows that firm size has a significant and positive effect on the value relevance of R&D expenditures, both in the UK and the US. The high-technology sector does not appear to have a significant effect on the value relevance of R&D expenditures.

Overall, this study is the first one to my knowledge to compare R&D accounting policy amongst these two markets, comparing two countries one of which applies the cash-expense and the other applies the successful-efforts method. Herewith, the outcomes of this research contribute to the debate on R&D accounting policy choice by providing highly generalizable and significant results. However, since this research can be categorized as a value relevance association study, which has been criticized extensively

(Barth *et al*., 2001; Holthausen and Watts, 2001), it has some caveats regarding practical inferences. Nevertheless, the information content of this research is not exclusively limited to the association of accounting numbers with a firm's market value. The results of this study can be regarded as a starting point when assessing R&D accounting policies. Suggestions for future research would include factors that affect the credibility of the signal that is provided by capitalized R&D in the financial statements. Also, it would be interesting to test the effects of voluntary disclosure on capitalized R&D expenditures, since management may have substantial discretion regarding the voluntary provision of R&D information. Therewith, they might want to influence the signal capitalized R&D gives to the users of the financial statements.

References

Aboody, D., and B. Lev. 2000. Information asymmetry, R&D, and insider gains. *The Journal of Finance* 55(6): 2747-2766.

Barth, M.E. 1991. Relative Measurement Errors Amon Alternative Pension Asset and Liability Measures. *The Accounting Review* 66: 433-463.

Barth, M.E., W.H. Beaver, and W.R. Landsman. 1996. Value Relevance of banks' fair value disclosures under SFAS 107. *The Accounting Review* 71: 513-537.

---. 2001. The relevance of the value relevance literature for financial accounting standard setting: another view. *Journal of Accounting and Economics* 31(1-3): 77-104.

Beaver, W.H. 2002. Perspectives on Recent Capital Market Research. *The Accounting Review*, 77(2): 453-474.

Cazavan-Jeny, A., and T. Jeanjean. 2006. The negative impact of R&D capitalization: A Value Relevance Approach. *European Accounting Review* 15(1): 37-61.

Chambers, D., R. Jennings, and R.B. Thompson. 2002. Excess Returns to R&D-Intensive Firms. *Review of Accounting Studies* 7: 133-158.

Chan, L.K.C., J. Lakonishok, and T. Sougiannis. 2001. The Stock Market Valuation of Research and Development Expenditures. *The Journal of Finance* 56(6): 2431-2456.

Cerqueti, R., D. Marazzina, and M. Ventura. 2016. Optimal Investment in Research and Development Under Uncertainty. *Journal of Optimization Theory and Applications* 168(1): 296-309.

Ciftci, M., and N. Zhou. 2016. Capitalizing R&D expenses versus disclosing intangible information. *Review of Quantitative Finance and Accounting* 46(3): 661-689.

Cohen, W.M., and S. Klepper. 1996. A Reprise of Size and R&D. *Economic Journal* 106: 925-951.

Connolly, R.A., and M. Hirschey. 2005. Firm Size and the Effect of R&D on Tobin's q. *R&D Management* 35(2): 217-223.

Core, J., W. Guay, and A. van Buskirk. 2003. "Market Valuations in the New Economy: An Investigation of what has changed". *Journal of Accounting and Economics* 34(1-3): 43-67.

Corrado, C.A., and C.R. Hulten. 2010. "Measuring intangible capital: how do you measure a 'technological revolution'?". *American Economic Review* 100(2): 99-104.

Dinh, T., B. Eierle, W. Schultze, and L. Steeger. 2015. Research and Development, Uncertainty, and Analysts' Forecasts: The Case of IAS 38. *Journal of International Financial Management & Accounting* 26(3): 257-293.

European Commission, EC. 2011. *Summary Report of the Responses Received to the Public Consultation of Disclosure on Non-Financial Information by Companies*. European Commission.

Financial Accounting Standards Board, FASB. 2001. *Improving Business Reporting: Insights into Enhancing Voluntary Disclosure*. Business Reporting Research Project, Steering Committee Report, FASB, Norwalk CT.

---. 2002. *Statement of Financial Accounting Concepts No. 2: Qualitative Characteristics of Accounting Information*. Original Pronouncements as Amended, FASB.

Fields, T., T. Lys, and L. Vincent. 2001. Empirical Research on Accounting Choice. *Journal of Accounting and Economics* 31(1-3): 255-307.

Francis, J., and K. Schipper. 1999. Have Financial Statements Lost Their Relevance?. *Journal of Accounting Research* 37(2): 319-352.

Franzen, L., and S. Radhakrishnan. 2009. The Value Relevance of R&D Across Profit and Loss Firms. *Journal of Accounting and Public Policy* 28(1): 16-32.

Graham, J.R., C.R. Harvey, and S. Rajgopal. 2005. The Economic Implications of Corporate Financial Reporting. *Journal of Accounting and Economics* 40: 3-73.

Heyden van der, Y., Smeyers-Verbeke, J., and Massart, D. L. 2006. Guidance for Robustness/Ruggedness Tests in Method Validation.

Hirschey, M., and R.S. Spencer. 1992. Size Effets in the Market Valuation of Fundamental Factors. *Financial Analysts Journal* 48(2): 91-95.

Healy, P.M., S.C. Myers, and C.D. Howe. 2002. R&D Accounting and the Tradeoff between Relevance and Objectivity. *Journal of Accounting Research* 40(3): 677-710.

Holthausen, R.M., and R. L. Watts. 2001. The Relevance of the Value-Relevance Literature for Financial Accounting Standard Setting. *Journal of Accounting and Economics* 31(3): 3-75.

IAS Plus. 2016. Retrieved April 28, 2016, from: http://www.iasplus.com/en/standards/ias/ias38.

Kanodia, C., and H. Sapra. 2016. A Real Effects Perspective to Accounting Measurement and Disclosure: Implications and Insights for Future Research. *Journal of Accounting Research* 54(2): 623-676.

Landsman, W. 1986. An Empirical Investigation of Pension Fund Property Rights. *The Accounting Review* 61: 662-691.

Leuz, C., and P.D. Wysocki. 2016. The Economics of Disclosure and Financial Reporting Regulation: Evidence and Suggestions for Future Research. *Journal of Accounting Research* 54(2): 525-622.

Lev, B., B. Sarath, and T. Sougiannis. 2005. R&D-Related Reporting Biases and Their Consequences. *Contemporary Accounting Research* 22(4): 107-138.

Lev, B., and T. Sougiannis. 1996. The Capitalization, Amortization and Value-Relevance of R&D. *Journal of Accounting and Economics* 21(1): 107-138.

Lev, B., and P. Zarowin. 1999. The boundaries of financial reporting and how to extend them. *Journal of Accounting Research* 37(2): 353-385.

Li, D. 2011. Financial Constraints, R&D Investment, and Stock Returns. *The Review of Financial Studies* 24(9): 2974-3007.

Maaloul, A., and D. Zéghal. 2015. Financial Statement Informativeness and Intellectual Capital Disclosure – an empirical analysis. *Journal of Financial Reporting and Accounting* 13(1): 66-90.

Malkiel, B.G. and E.F. Fama. 1970. Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance* 25(2): 383-417.

OECD. 2006. *Creating Value from Intellectual Assets*. Paper presented at meeting of OECD council at ministerial level, Paris.

Ohlson, J. 1995. Earnings, Book Values and Dividends in Security Valuation. *Contemporary Accounting Research* 11: 661-687.

Oswald, D.R., and P. Zarowin. 2007. Capitalization of R&D and the Informativeness of Stock Prices. *European Accounting Review* 16(4): 703-726.

Oswald, D.R. 2008. The Determinants and Value Relevance of the Choice of Acocunting for Research and Development Expenditures in the United Kingdom. *Journal of Business Finance and Accounting* 35: 1-24.

Penman, S.H., and X-J. Zhang. 2002. Ratio Analysis and Equity Valuation: From Research to Practice. *Review of Accounting Studies* 6: 109-154.

Pindado, J., V. de Queiroz, and C. de la Torre. 2010. How Do Firm Characteristics Influence the Relationship between R&D and Firm Value?. *Financial Management* 39(2): 757-782.

Ruch, G.W., and G. Taylor. 2015. Accounting Conservatism: A review of the literature. *Journal of Accounting Literature* 34: 17-38.

Securities and Exchange Commission, SEC. 2003. *Management's Discussion and Analysis*. SEC, Washington DC.

Scott, W.R. 2012. *Financial Accounting Theory*: 6st ed. Pearson.

Shah, S.Z.A., S. Liang, and S. Akbar. 2013. International Financial Reporting Standards and the Value Relevance of R&D expenditures: Pre- and Post-IFRS Analysis. *International Review of Financial Analysis* 30(1): 158-169.

Shah, S.Z. A., A. Stark, and S. Akbar. 2008. Firm Size, Sector and Market Valuation of R&D expenditures, *Applied Financial Economics Letters* 4: 87-91.

---. 2009. The Value Relevance of Major Media Advertising Expenditures: some UK evidence. *International Journal of Accounting* 44: 187-206.

Shortridge, R.T. 2004. Market Valuation of Successful Versus Non-Successful R&D efforts in the Pharmaceutical Industry. *Journal of Business Finance & Accounting* 31: 1301-1325.

Skinner, D.J. 2008. Accounting for Intangibles – A Critical Review of Policy Recommendations. *Accounting and Business Research* 38(3): 191-204.

Sonnier, B. 2008. Intellectual Capital Disclosure: High-tech versus Traditional Sector Companies. *Journal of Intellectual Capital* 9(4): 705-722.

Tsoligkas, F., and I. Tsalavoutas. 2011. Value Relevance of R&D in the UK after IFRS Mandatory Implementation. *Applied Financial Economics* 21(3): 957-967.

Watts, R.L. 2003. Conservatism in Accounting – Part I: Explanations and implications. *Accounting Horizons* 17(3): 207-221.

Watts, R.L., and J.L. Zimmerman. 1983. Agency Problems, Auditing and the Theory of the Firm: Some Evidence. *Journal of Law and Economics* 26: 273-305.

Zéghal, D., and A. Maaloul. 2011. The Accounting Treatement of Intangibles – A Critical Review of the Literature. *Accounting Forum* 35(4): 262-274.

Zhao, R. 2002. Relative Value Relevance of R&D Reporting: An International Comparison. *Journal of International Financial Management and Accounting* 13(2): 153-174.

Appendix A Literature Review

Table 7. *Literature Overview*

3.1 Value Relevance and R&D Research				
Authors	*Research Question*	*Research Methodology*	*Sample*	*Conclusion*
Lev and Sougiannis (1996)	Is there an association between R&D expenditures and earnings? Is this association economically meaningful?	Regression Analysis.	US firms 1975-1991. Compustat R&D Master File	R&D capitalization yields statistically reliable and economically relevant information.
Chan, Lakonishok and Sougiannis (2001)	Do stock prices fully value firm's intangible assets? (especially regarding R&D)	Cross-sectional regression analysis; Fama and Macbeth (1973) approach.	US firms listed on NYSE, AMEX and Nasdaq, 1975-1995. Compustat	There is no direct link between R&D spending and future stock returns.
Tsoligkas and Tsalavoutas (2011)	Are R&D reported assets and expenditures value relevant after the adoption of IFRS in the UK?	Regression Analysis, extended Ohlson (1995)-model.	UK firms listed in the AIM and FTSE with R&D activity, using 2006-2008 UK Scoreboards. DataStream	Positive value relevance for the capitalized R&D portion of R&D expenditures under IFRS.
Shah, Liang and Akbar (2013)	Pre- and Post-IFRS value relevance examination of R&D expenditures.	Regression Analysis, extended Ohlson (1995)-model.	UK listed firms involving R&D activity, 2001-2011. DataStream	Positive value relevance of capitalized R&D, no value relevance of expensed R&D.

3.2 R&D Capitalization vs. Expensing				
Authors	*Research Question*	*Research Methodology*	*Sample*	*Conclusion*
Lev and Zarowin (1999)	Investigation of the decision usefulness of financial information towards investors.	Cross-sectional regression analysis, cash-flow return relation	US firms, 1976-1996. Compustat	There is a deterioration of financial information usefulness over recent history.
Healy *et al.* (2002)	Simulation model, in order to provide evidence on the tradeoff between objectivity and relevance in reporting for R&D outlays.	Regression analysis, returns model (testing return-earnings relation)	500 simulated pharmaceutical firms over 32 years	Successful-efforts method is more highly correlated with economic returns than the cash-expense or full-cost method.

Oswald and Zarowin (2007)	Does R&D capitalization lead to more informative stock prices relative to expensed R&D?	Regression analysis, regressing current annual stock returns on current and future annual earnings changes (ERC analysis).	UK firms, 1990-1999. DataStream	Capitalization of R&D results in more market information. Share prices are more informative under the successful-efforts method.
Ciftci and Zhou (2016)	How can value-relevance of financial information for intangible-intensive firms be enhanced: via capitalizing or disclosure on intangible information?	Regression analysis, Patent counts/citations as a proxy for intangible intensity	US- firms granted US patents issued 1975-2006 using NBER Patent data 2006 update. Compustat and CSRP	Application of cash-expense method together with intangible disclosure is more value relevant than capitalization (for the high-patent part of the sample). For the medium- and low-patent sample capitalization is more value relevant.

3.3 Firm Size

Authors	*Research Question*	*Research Methodology*	*Sample*	*Conclusion*
Hirschey and Spencer (1992)	The effects of size on market valuation of fundamental factors.	Divide the sample in small, medium and large firm sizes and measure market valuation by relative excess valuation.	US firms 1975-1990. Compustat	Amongst different firm size classes, there is a difference regarding value relevance R&D expenditures to market valuations. - no difference for small and medium sized firms - difference for large firms
Connolly and Hirschey (2005)	Valuation consequences of R&D investments by firms different of size.	Tobin's *q* ratio.	Pooled cross-section US sample, 1997-2001. Compustat	A dollar of R&D spending is more effective regarding firm value under larger than smaller firms.
Cazavan-Jeny and Jeanjean (2006)	Assessment of value relevance of R&D reporting in France.	Different specifications of the Ohlson (1995)-model.	French firms with R&D activity, 1993-2002. Woldscope-Thomson database	Less positive value relevance when R&D is capitalized opposed to expensed. Firms which choose to capitalize successful R&D projects are smaller.

Pindado et al. (2010)	How do firm characteristics influence market valuation of R&D expenditures?	Regression analysis, studying the relationship between R&D and firm value.	Data from Eurozone countries, 1986-2003. Worldscope-Thomson database	Firm characteristics moderate firm value and R&D outlays. Most specifically firm size exerts a strong positive effect.

3.4 Technology Sector

Authors	*Research Question*	*Research Methodology*	*Sample*	*Conclusion*
Sonnier (2008)	A comparison of intellectual capital disclosure in the US	Content analysis, capturing frequency of words of phrases when describing IC resources of firms.	US firms with certain NAICS codes, 2000-2004.	High-technology firms typically disclose more on their Intellectual Capital. Value relevance of accounting information deteriorates over time.
Maaloul and Zéghal (2015)	Empirical analysis of the relationship between financial statement informativeness and intellectual capital disclosure.	Dividing the sample in high- and low-tech companies. Regression analysis on IC disclosure.	US firms listed on the S&P500 index during 2009.	Financial statement informativeness of high-tech firms is significantly lower than that of low-tech firms.

Appendix B Sample

Table 8. *Description of Variables*

Variable	Description
MV_{it}	Market value of firm *i* in period *t*. MV_{it} is measured three months after the fiscal year end of firm *i*. Market value equals the number of shares outstanding multiplied by the share price.
E_{it}	Earnings of firm *i* in period *t*.
BVE_{it}	Book value of equity of firm *i* in period *t*.
RD_{it}	Annual amount R&D expenditures of firm *i*.
RDsize	Slope-dummy control variable on firm size. Firm size is classified on median market value of equity. Indicator values for size are multiplied by R&D.
RDHT	Slope-dummy control variable on the high-technology sector. HT=1 if the firm operates in one of the high-tech sectors and HT=0 if the firm does not operate in one of these sectors. These indicator values are multiplied by R&D. Classification is according to SIC codes (Table 3, Appendix B).

Table 9. *Industries Included in the High-Technology Sample*

SIC-code	**High-Technology Industries**
283	Drugs
357	Computer and Office Equipment
360	Electrical Machinery and Equipment, Excluding Computers
361	Electrical Transmission and Distribution Equipment
362	Electrical Industrial Apparatus
363	Household Appliances
364	Electrical Lighting and Wiring Equipment
365	Household Audio, Video Equipment, Audio Receiving
366	Communication Equipment
367	Electronic Components, Semiconductors
368	Computer Hardware
481	Telephone Communications
737	Computer Programming, Software, Data Processing
873	Research, Development and Testing Services

Appendix C Regression Analysis

Fig. 2. *Histograms of Variables –US sample*

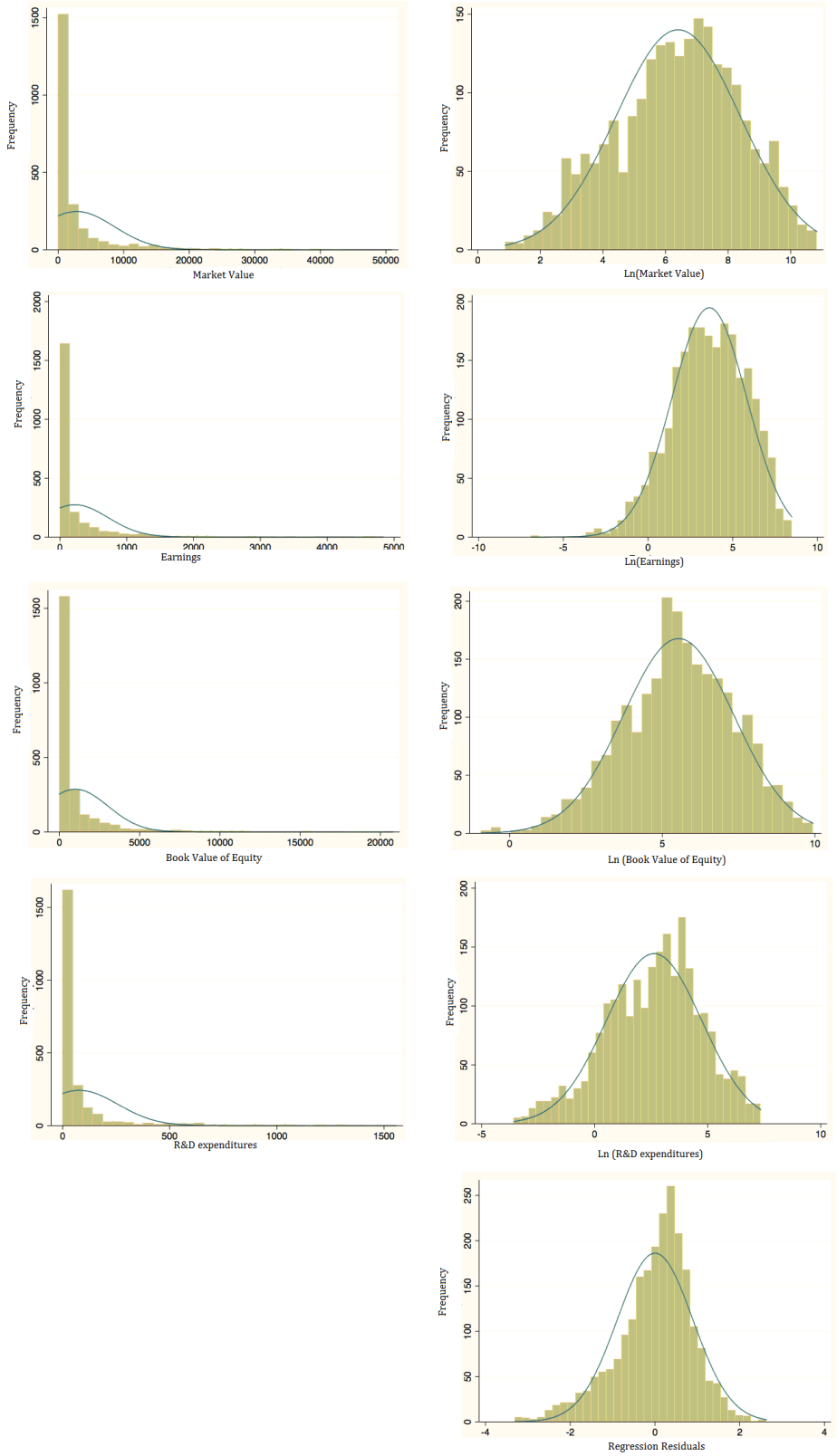


Fig. 3. *Histograms of Variables – UK Sample*

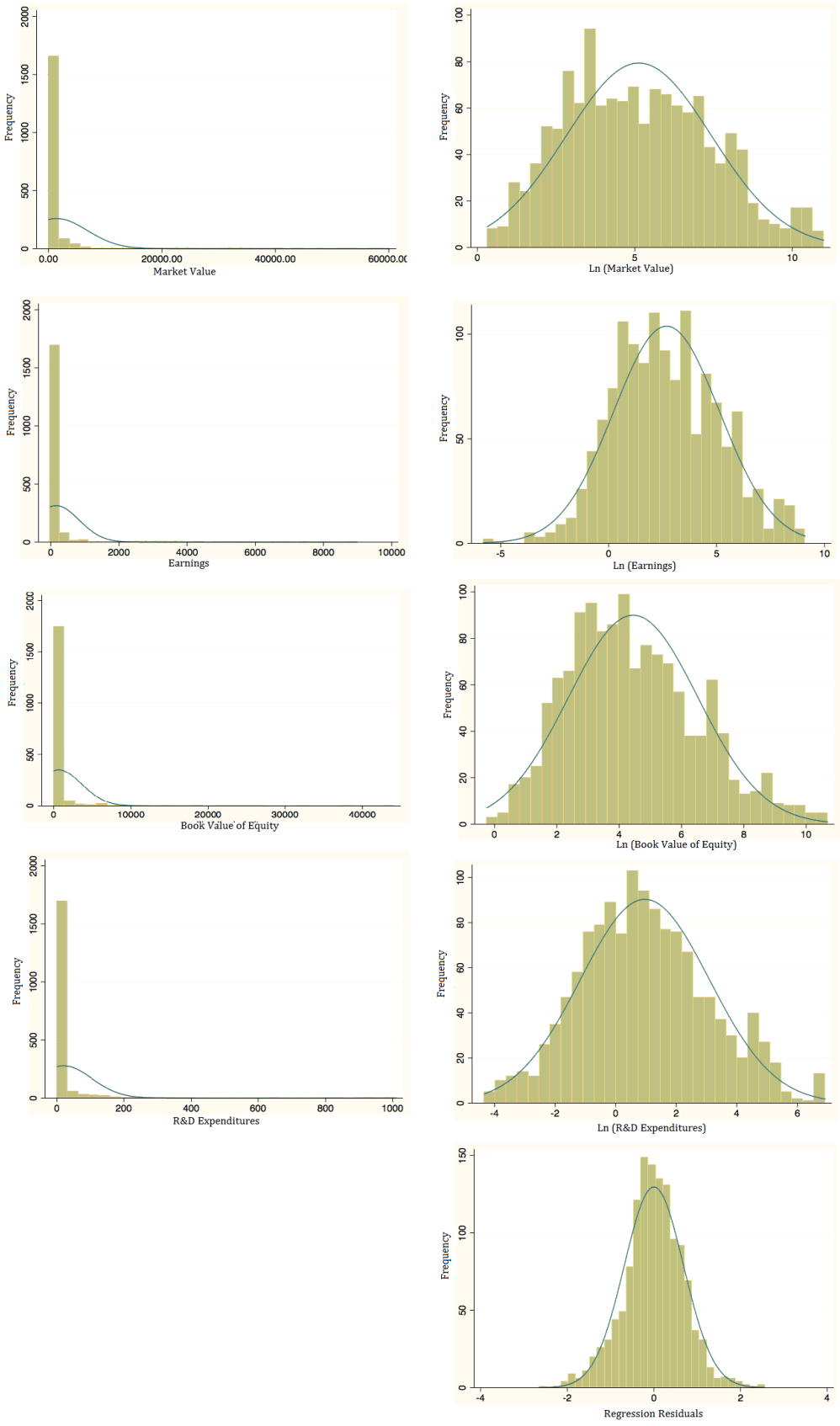


Table 10. *Hausman Test*

Hausman test results		
	US sample	*UK sample*
Chi^2	93.29	58.76
P-value	0.000	0.000
H_0: Difference in coefficients is not systematic (apply RE model)		
H_1: Difference in coefficients is systematic (apply FE model)		

Table 11. *Breusch-Pagan Heteroscedasticity Test*

Breusch-Pagan test results		
	US sample	*UK sample*
Chi^2	140.25	148.10
P-value	0.000	0.000
H_0: There is constant variance amongst the standard deviations of the variables – no heteroscedasticity		
H_1: There is clustered variance amongst the standard deviations of the variables – heteroscedasticity exists		

Table 12. *Pearson Correlation Matrix – US sample*

Pearson correlation matrix – US Sample						
	MV	E	BE	RD	RDsize	RDHT
MV	1.000					
E	0.848*	1.000				
	0.000					
BVE	0.881*	0.854*	1.000			
	0.000	0.000				
RD	0.801*	0.662*	0.740*	1.000		
	0.000	0.000	0.000			
RDsize	0.694*	0.641*	0.657*	0.641*	1.000	
	0.000	0.000	0.000	0.000		
RDHT	0.371*	0.196*	0.310*	0.519*	0.366*	1.000
	0.000	0.000	0.000	0.000	0.000	

Reported values are Pearson's Correlations. Definitions of variables are as described in Table 2, Appendix B. * denotes significance at the 5%-level (two-tailed).

Table 13. *Pearson Correlation Matrix – UK sample*

Pearson correlation matrix – UK sample						
	MV	E	BE	RD	RDsize	RDHT
MV	1.000					
E	0.944*	1.000				
	0.000					
BVE	0.940*	0.934*	1.000			
	0.000	0.000				
RD	0.709*	0.667*	0.668*	1.000		
	0.000	0.000	0.000			
RDsize	0.640*	0.614*	0.626*	0.638*	1.000	
	0.000	0.000	0.000	0.000		
RDHT	0.209*	0.187*	0.191*	0.474*	0.103*	1.000
	0.000	0.000	0.000	0.000	0.000	

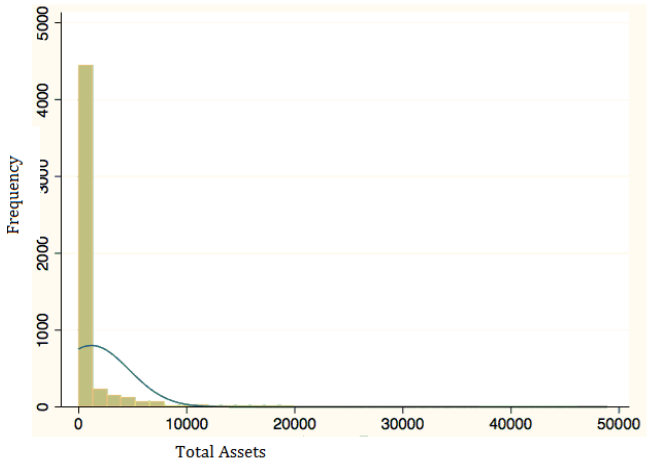
Reported values are Pearson's Correlations. Definitions of variables are as described in Table 2, Appendix B. * denotes significance at the 5%-level (two-tailed).

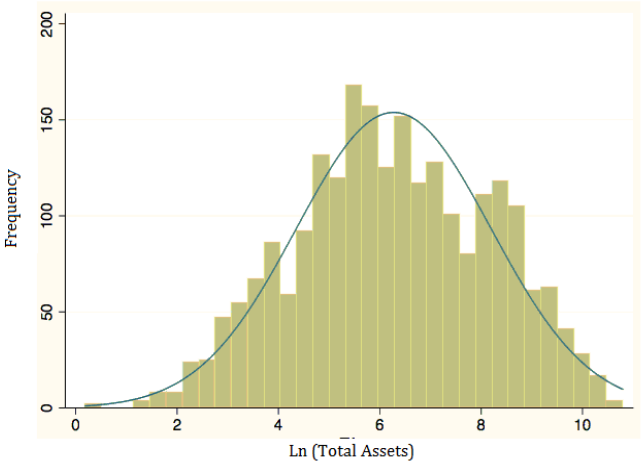
Table 14. *VIF Test*

VIF values		
	US sample	***UK sample***
Variable	VIF value	VIF value
E	4.71	8.21
BVE	4.07	8.08
RD	2.98	2.96
RDsize	2.05	2.05
RDHT	1.48	1.43
Mean VIF	3.06	4.55

Appendix D Robustness Check

Fig 4. *Histograms of Variables Robustness Check – US Sample*





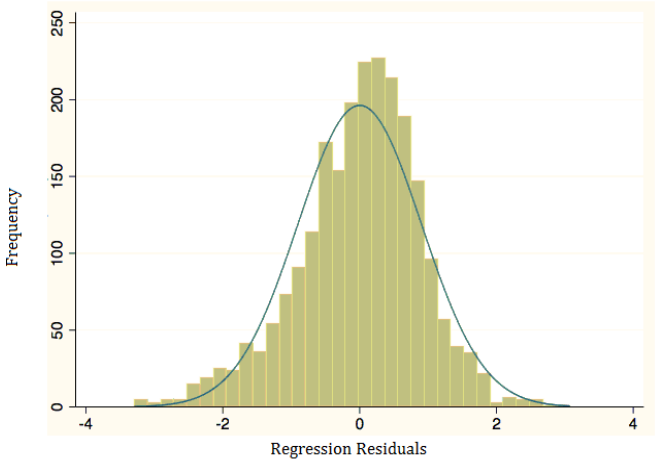
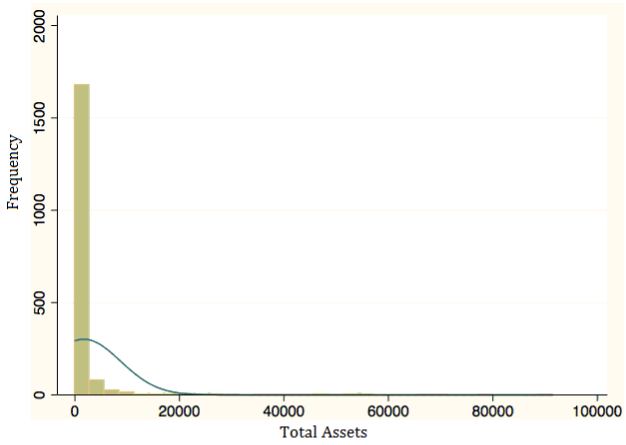
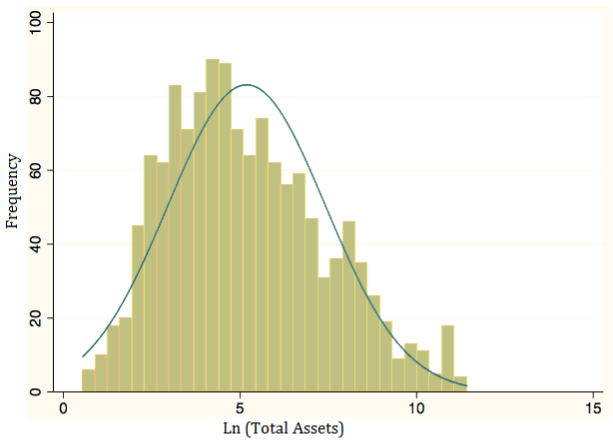


Fig. 5. *Histograms of Variables Robustness Check – UK Sample*





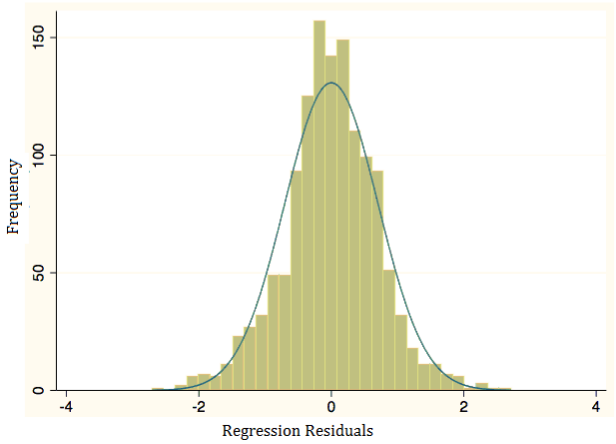


Table 15. *Hausman Test – Robustness Check*

Hausman test results - Robustness check		
	US sample	*UK sample*
Chi^2	86.36	62.86
P-value	0.000	0.000
H_0: Difference in coefficients is not systematic (apply RE model)		
H_1: Difference in coefficients is systematic (apply FE model)		

Table 16. *Breusch-Pagan Heteroscedasticity Test – Robustness Check*

Breusch-Pagan test results – Robustness check		
	US sample	*UK sample*
Chi^2	113.86	150.58
P-value	0.000	0.000
H_0: There is constant variance amongst the standard deviations of the variables – no heteroscedasticity		
H_1: There is clustered variance amongst the standard deviations of the variables – heteroscedasticity exists		

Table 17. *Pearson Correlation Matrix– US sample – Robustness Check*

Pearson correlation matrix – Robustness check, US sample 2006-2016						
	MV	E	BE	RD	RDsize	RDHT
MV	1.000					
E	0.846*	1.000				
	0.000					
BVE	0.881*	0.853*	1.000			
	0.000	0.000				
RD	0.801*	0.660*	0.738*	1.000		
	0.000	0.000	0.000			
RDsize	0.721*	0.723*	0.744*	0.711*	1.000	
	0.000	0.000	0.000	0.000		
RDHT	0.371*	0.195*	0.310*	0.519*	0.312*	1.000
	0.000	0.000	0.000	0.000	0.000	

Reported values are Pearson's Correlations. Definitions of variables are as described in Table 2, Appendix B. * denotes significance at the 5%-level (two-tailed).

Table 18. *Pearson Correlation Matrix – UK sample – Robustness Check*

Pearson correlation matrix – Robustness check, UK sample 2006-2016						
	MV	E	BE	RD	RDsize	RDHT
MV	1.000					
E	0.944*	1.000				
	0.000					
BVE	0.940*	0.933*	1.000			
	0.000	0.000				
RD	0.709*	0.666*	0.667*	1.000		
	0.000	0.000	0.000			
RDsize	0.613*	0.606*	0.623*	0.606*	1.000	
	0.000	0.000	0.000	0.000		
RDHT	0.210*	0.188*	0.193*	0.476*	0.079*	1.000
	0.000	0.000	0.000	0.000	0.000	

Reported values are Pearson's Correlations. Definitions of variables are as described in Table 2, Appendix B. * denotes significance at the 5%-level (two-tailed).

Table 19. *VIF Test – Robustness Check*

VIF values		
	US sample	***UK sample***
Variable	VIF value	VIF value
E	4.78	8.20
BVE	4.09	8.02
RD	3.15	2.84
RDsize	2.73	1.96
RDHT	1.45	1.44
Mean VIF	3.24	4.49