Norwegian School of Economics

Bergen, Spring 2021



# Development of intangible assets: Challenging the current accounting practices

*A Quantatative Research*

**Magnus Vie Pettersen & Harald Müller Thomassen**

**Supervisor: Prof. Ivan Belik**

Master thesis:

Business Analytics (BAN) & Business Management (BUS)

NORWEGIAN SCHOOL OF ECONOMICS

# Preface

This thesis was written as part of the Master of Science in Economics and Business Administration, majors in Business Analytics (BAN) and Business Management (BUS) at the Norwegian School of Economics. Throughout this thesis, we have gained valuable insight and experience regarding accounting and the topic of intangible assets. Furthermore, our abilities within the concept of empirical methods as well as critical problem solving and analysis have also been enhanced.

We want to express our gratitude to our supervisor, Professor Ivan Belik, who gave us guidance and valuable feedback through his expertise. Despite limitations caused by the ongoing COVID-19 pandemic, sufficient virtual solutions for supervising were offered and executed professionally. An extension of our appreciation goes to family and friends who assisted in reviewing the thesis, which was of importance when deciding how to finalize and shape the presentation of our work.

# Abstract

In this thesis, we investigate how the usage and development of intangible assets depreciate the relevance of accounting. Previous research suggests that the accounts historically have been a precise tool for predicting the stock price and, hence, the company's market valuation. In the past decades, both the explanatory capability and, subsequently, the accuracy of accounting have dropped with significance. We apply four quantitative experiments on a sample of Norwegian firms, both non-listed and listed on the Oslo Stock Exchange, between 2005-2018 to measure explanatory rates, prediction errors, valuation of stated intangible assets, and the amount of inherent goodwill. Initial test results indicated a partial depreciation of the robustness of accounting figures. Removal of the petroleum industry in the conducted experiments strengthens the assurance of the initial result. Additionally, other experiments indicate that the market positively values the reported intangible assets. Further investigations also show an increasing trend in the amount of inherent goodwill.

# Contents

**PREFACE** ..... **II**

**ABSTRACT** ..... **III**

**CONTENTS** ..... **IV**

**1. INTRODUCTION** ..... **1**

**2. THEORY AND LITERATURE REVIEW** ..... **3**

2.1 INTANGIBLE ASSETS ..... 3

*2.1.1 Definition of intangibles* ..... *3*

*2.1.2 Properties of intangibles assets* ..... *4*

*2.1.3 Type of intangible assets* ..... *6*

*2.1.4 Accounting Standards* ..... *8*

*2.1.5 Estimating value of intangible assets* ..... *10*

*2.1.6 Data as an asset* ..... *11*

2.2 ACCOUNTING ..... 12

*2.2.1 Relevance of accounting* ..... *13*

*2.2.2 Utilization of accounting information* ..... *14*

*2.2.3 Investors' irrational behaviour* ..... *16*

*2.2.4 Disagreement between investors* ..... *18*

**3. METHODOLOGY** ..... **19**

3.1 RESEARCH DESIGN ..... 19

3.2 RESEARCH STRATEGY AND OBJECTIVE ..... 20

3.3 DATA COLLECTION ..... 22

*3.3.1 Primary data* ..... *22*

*3.3.2 Merging market data and accounting data* ..... *23*

*3.3.3 Industrial Classification* ..... *24*

*3.3.4 Excluding non-profit maximizing firms* ..... *24*

*3.3.5 Secondary data* ..... *25*

3.4 ANALYSIS APPROACH ..... 25

*3.4.1 Data Weakness* ..... *25*

*3.4.2 Credibility* ..... *26*

*3.4.3 Validity* ..... *26*

*3.4.4 Reliability* ..... *28*

*3.4.5 Regression Analysis* ..... *28*

*3.4.6 Criteria for an Unbiased OLS Regression* ..... *30*

*3.4.7 Wilcoxon Signed T-test* ..... *31*

3.5 METHODS ..... 33

*3.5.1 Previewing Experiment 1: Market Value Hypothesis* ..... *33*

*3.5.2 Previewing Experiment 2: Earning Estimate Hypothesis* ..... *36*

*3.5.3 Previewing Experiment 3: Balance Sheet Hypothesis* ..... *38*

*3.5.4 Previewing Experiment 4: Inherent Goodwill Hypothesis* ..... *41*

**4. ANALYSIS ..... 44**

*4.1.1 Experiment 1: Market Value Hypothesis* ..... *44*

*4.1.2 Experiment 2: Earnings Estimate Hypothesis* ..... *49*

*4.1.3 Experiment 3: Balance Sheet Hypothesis* ..... *51*

*4.1.4 Experiment 4: Inherent Goodwill Hypothesis* ..... *59*

*4.1.5 Accumulation of experiments* ..... *65*

**5. DISCUSSION ..... 67**

5.1 COMPARISON OF REVIEWED LITERATURE RESULTS ..... 67

*5.1.1 Comparing the application of accounting* ..... *67*

*5.1.2 Comparison of intangible assets* ..... *70*

5.2 LEGITIMACY OF ACCOUNTING ..... 71

*5.2.1 The relation between the market the accountings* ..... *71*

*5.2.2 Confidence in the experiments* ..... *72*

5.3 RELEVANCE OF INTANGIBLE ASSETS ..... 73

*5.3.1 Valuation of intangible assets* ..... *74*

*5.3.2 Assessment of the confidence in the test results* ..... *74*

*5.3.3 Characteristics of development* ..... *76*

5.4 PROPOSED CHANGES ..... 77

*5.4.1 Stick to status quo* ..... *77*

*5.4.2 Allowing to display unidentifiable intangible assets* ..... *78*

*5.4.3 Strategic Resource Planning* ..... *78*

**6. CONCLUSION ..... 81**

**REFERENCES ..... 82**

**APPENDIX ..... A**

[1] DATA FROM SNF ..... A

[2] NACE CODES ..... B

[3] CROSS-SECTIONAL MATCHING PROCEDURE ..... C

[5] EXPERIMENT 1: REVISED OLS REGRESSION RESULTS ..... G

[6] EXPERIMENT 1: CORRELATION MATRIX ..... J

[7] EXPERIMENT 3: MEAN VALUES MVBSH ..... K

[8] WILCOXON SIGNED RANKED T-TEST MVBSH ..... L

[9] EXPERIMENT 3: MEAN VALUES ABSH ..... M

[10] WILCOXON SIGNED RANKED T-TEST ABSH ..... P

[11] EXPERIMENT 3: OLS REGRESSION ANALYSIS ..... Q

[12] EXPERIMENT 3: REVISED OLS REGRESSION RESULTS ..... T

**Constent of tables**

Table 1 Result of regression analysis for experiment 1 ..... 45

Table 2 Correlation matrix ..... 46

Table 3: Results from OLS Regression analysis for the year 2013..... 46

Table 4: Development of adjusted R2 ..... 47

Table 5: Development of the prediction error ..... 49

Table 6: Number of observations in the experimental portfolio ..... 51

Table 7: Number of observations in the control portfolio ..... 52

Table 8: Results of the Wilcoxon Signed Ranked t-test of MVBSH ..... 54

Table 9: Results from the Wilcoxon Signed Paired t-test of ABSH ..... 55

Table 10: Results from OLS regression analysis for experiment 3..... 57

Table 11 Top 25% (Experiment 4):..... 60

Table 12: bottom five companies (Experiment 4)..... 62

Table 13: Overvaluation analysis ..... 63

**Content of figures**

Figure 1: Graphical visualisation of the development of adjusted $R^2$ ..... 47

Figure 2: Graphical visualisation of both the initial development of adjusted $R^2$ ..... 48

Figure 3: Graphical visualisation of the development of the prediction error ..... 50

Figure 4: Observation in the experimental portfolio ..... 52

Figure 5: Development of observations in the control portfolio ..... 53

Figure 6: Ratio between observation in the experimental and control portfolio..... 53

Figure 7: Estimation value for the coefficient of the intangible asset predictor variable.. .... 58

Figure 8: Top 25% (Experiment 4), figures of IG are shown in per million ..... 59

Figure 9: Median (Experiment 4), figures of IG is shown in per million ..... 60

Figure 10: Bottom 25% (Experiment 4), figures of IG is shown in per million ..... 61

Figure 11: Trend of all firms (Experiment 4), figures of IG is shown in per million ..... 62

Figure 12: Proportion of number of firms in each industry ..... 68

# 1. Introduction

Accounting has always been a core aspect of both controlling- and commercial institutes offering a structured valuation over components and assets. Until the 20th century, the essence and procedure of accounting have been following the same key concepts, consistently returning a high rate of explanatory power, that is, the accounts ability to reflect a firm's market valuation. As we entered the third industrial revolution and the emergence of *information technology* leading to the enrollment of the internet in the 1990s, researchers have found that the rate of the explanatory power of accounting has been steadily dropping with significance, arguing for a lower capability of representing a firm's actual value.

When referring to a company's market value, the term market capitalization is frequently used, which essentially refers to the company's outstanding stocks multiplied with its stock price. This value will revolve around expectation to profitability, and hence the stock market tends to value firms by the potential that lies with their means of value creation. This potential generally derives from the firm's ability to achieve superior competitive performance by utilizing its strategic assets. Today, the long term perspective towards profitability is often associated with a strategic utilization of databases, sustainable and efficient processes, and inducement of research and development, which all can be accumulated under the same term: utilization of *intangible assets*. Per definition, assets are *"An identifiable non-monetary assets without physical substance"* (IAS 38). The presence of this type of asset is increasing exponentially as enterprises are starting to realize the high potential it holds in terms of value creation. Entering the fourth industrial revolution and the introduction of artificial intelligence, machine learning, big data, and other powerful interfaces makes it seem inevitable that the ratio of intangible assets potentially might increase rapidly. Despite this, there have not been any significant changes in terms of regulations of intangible assets in financial statements, ultimately implying that the explanatory rate of accounting can continue to drop to a critical level.

In this thesis, we measure the effect and development of intangible assets in Norwegian businesses. Our approach will be inspired by previous research from the accounting, finance, and law professors Baruch Lev and Feng Gu, who accumulated their research and wrote *The End of Accounting and the Path Forward for Investors and Managers* (2016). Briefly summarized, they found that current accounting practices are gradually weakening their

relevance and point in the direction of increasing utilization of intangible assets. This literature will be thoroughly reviewed in our theory and literature review section as it creates the fundament for our thesis. We aim to detect the same trend depicted in their research of international markets, but for firms operating in Norway. If a positive correlation is proven between our results and the existing one, we will have an enhanced claim towards revising the current regulations regarding the framework of reporting intangible assets. Specifically, this thesis aims to answer the following research question:

*"Does the characteristics of the development regarding intangible assets challenge the legitimacy of accounting, subsequently making the current reporting framework outdated?"*

This thesis will be structured in a sensible manner offering transparency to all readers regardless of their current levels of knowledge on the topic at hand. A theory and literature review will follow this introduction to establish a theoretic magnitude for our research area. After, a methodology section containing an explanation of our general approach as well as the substance of our experiments will be presented. The next step will then include specific results from our experiments and the corresponding interpretation. To finalize the thesis, a discussion and conclusion section will be made to discuss further the full meaning of the results and potential implications that lay with their means.

In the following section, the theory and literature review, the definition and concept of intangible assets will be thoroughly discussed before presenting relevant references regarding accounting and digitalization to augment the necessary theoretic background before assessing the adopted methodology.

# 2. Theory and literature review

This chapter covers the academic background for the thesis, and hence it will contain the necessary information to establish the theoretical foundation for our approach. In the first part of this section, the concept of intangible assets will first be assessed to give the reader a concrete definition and comprehension of which areas it applies. Different accounting standards have different rules for displaying some of these values. Therefore, the definition of intangibles will be followed by a light review of the three most relevant ones for our thesis: General Accepted Accounting Principles (GAAP), International Financial Reporting Standards (IRFS) and Norwegian Accounting Standards (NRS). The second part of this section has a focus on accounting. Here, the main portion of relevant research and its complementary approaches, findings, and implications, will be discussed to assist in bringing empirical magnitude and inspiration for this study.

## 2.1 Intangible assets

The purpose of this section is to elaborate on the relationship between intangible assets and the raising concerns regarding accounting. The essence is about defining what intangible assets are and their properties. Further, the implication these properties implicate for the firm. The process of describing this is greatly influenced by the book of Jonathan Haskel and Stian Westlake *Capitalism without Capital* (2018). They discuss multiple and interesting perspectives regarding intangible assets and its implication and utilize their background from both academia and legislation consulting concerning this subject. The book is based on the idea that intangible assets consist of four fundamental properties: *Scalability, Spillover, Sunkenness,* and *Synergies*. These are recognized as the 4 S'.

### 2.1.1 Definition of intangibles

The intuitive understanding of intangible assets is that they are assets that do not retain a physical substance. Equivalent to tangible, these assets are still something that the firm can possess. Referring to the International Financial Reporting Standards (IFRS) definitions, the key property of an assets is: "*…a resource that is controlled by the entity as a result of past events and from which future economic benefits are expected."* (IAS 38). The very nature of intangibles, however, requires the firm to assess them differently. Tangibles are considerably

more convenient to assess because the cost of acquisition or development are more specific and available. In his earlier works, Lev (2001) emphasize on the potential that are inherent within the intangible assets when he defines them as: "*claims to future benefits that does not have a physical or financial embodiment* " (2001, p. 5). Hulten (2010) describe intangible assets as something : "*…typically involves the development of specific products or processes, or are investments in organizational capabilities, creating or strengthening product platforms that position a firm to compete in certain markets… involves use of knowledge… and organizational know-how*" (2010, pp. 5-6). After the collapse of the "dot.com" bubble in 2000, C. A. Corrado, Hulten, and Sichel (2005) created a framework for that purpose to better understand the implication, among others, intangible assets have for the economy. They submitted an early estimate on how much American firms were investing in intangible assets. Influenced by e.g. Young (1998), these publications raised awareness of the increasing concerns regarding intangibles in the policy and political circles through the 2000's.

### 2.1.2 Properties of intangibles assets

Haskel and Westlake (2018) summarize four distinct properties of intangible assets which they call *the 4 S':* Scalability, Sunkenness, Spillovers, and Synergies. Scholars of endogenous growth theory like Romer (1994); Jones (1996); Aghion and Howitt (1998) proclaimed the term "non-rivalry" to understand knowledge goods like ideas, know-hows, etc. These are capabilities that are not exclusive to one firm and can, in theory, be used by others. They use this term to describe the scalability of intangible assets. As Haskel and Westlake describe, physical assets can only be in one place at the same time. Therefore, they are limited to create value from where they are located. Scaling up tangible assets is heavily dependent on the type of asset and its purpose and usually consists of increasing efficiency. Intangible assets can, because of their nonphysical nature, be used multiple places and multiple times. The amount of R&D behind a new electrical car might be tremendous, but the same design can be used an indefinite number of times. Therefore, the distribution of the initial R&D costs is spread over all the produced cars. The design itself can also be used multiple times and tweaked accordingly. This further implies that the non-rivalry asset can be implemented and adapted differently between firms, and the effectiveness would therefore fluctuate. This is why multiple food delivery services, electrical scooter rentals, or ride-haling providers are found in the same market. The fundamental idea is similar, but the

business model and utilization of its assets might differ. Haskel and Westlake (2018, p. 67) suggest that “network effects have a huge impact on the scalability property”. They denote that “networks like UBER and Airbnb, the power of HTLM and the Web in general, are made up of components that are intangible.”

The second property of intangibles is what they call sunkenness. This is referred to as sunk cost, which most intangibles, in fact, are. Tangible assets on the other hand, can have their acquisition reversed by selling them off again. An amortization cost might apply, but in most situations, their value is salvageable. This cannot be applied to intangible assets. Haskel and Westlake point towards two main reasons why tangible assets are less likely to be a sunk investment. First, standardization and mass production create a second-hand market with high demand. Second, most intangible assets are either acquired or developed to fit one specific customer's needs. The absence of versatility of intangibles prevents the assets from being used in other places and are therefore more complicated to sell-off. A. Dixit (1992) argues that waiting to avoid sunk cost can be imposed value if there is uncertainty involved. A. K. Dixit and Pindyck (1995) builds further on this model and proposes a two-stage example, which shows that investing in intangible assets with unresolved uncertainty in stage one, can be imposed value if it reveals decision information associated with stage two. Haskel and Westlake argue that this might be seen in context with C. A. Corrado and Hulten (2010) and what they call a strategic property.

The non-rivalry characteristics of scalability facilitate the third property and an important component of intangibles, namely spillovers. Haskel and Westlake appoint the first ideas of spillovers to the distinguished economist Alfred Marshall, renowned for his early contribution to neoclassical economics. Arrow (1972); and Romer (1990) developed the theory further, where Arrow was the first to formulate spillovers mathematically. Griliches (1992); and Glaeser et al. (1992) displayed the *Marshall-Arrow-Romer* model, which explains spillovers between firms within the same industry. Intangible assets can be directly copied or influence new assets significantly compared to tangible assets. Similar firms located in close proximity to each other increases the risk of spillovers. Preventing spillovers for tangible assets is much more applicable than for intangibles. The reason for this is related to the legal protection of tangible assets. Patents and property laws regulate the risk of spillovers by protecting the ownership of said assets. Intangible assets are more complicated in that matter because the capabilities of the legislators are limited. The ownership of ideas, knowledge, know-hows, code and excel macros are more complicated to formulate. In a

situation where for example a bank employee utilizes a Python script in relation to a business intelligence program (e.g., Power BI), those lines of code might be obtained from an open-source site like GitHub or Stack Overflow. The bank employee could take ownership of that solution which the employer could file as inherent intangible assets. On the other side, these are assets that were created from free and open-sourced resources that a group or individual with no affiliation with the bank created in the first place. Issues regarding captivating ownership of intangible assets are one of those reasons that increase the risk of spillovers. Haskel and Westlake summarize three central factors for why spillovers matter (2018, p. 77): "First, one should expect firms that are not definite about obtaining benefits from their investment to invest less. Second, firms that manage their spillovers are expected to do well. Third, spillovers are affecting the geography of the modern economy."

Intangible assets are more convenient to pair with other intangibles than tangibles assets because of their non-physical nature. This creates synergies which is the last component of intangible assets. Computers can be smart, efficient, and tweaked as desired. By itself however, the usage is limited to what it was designed to do in the first place. Connect a billion computers together through the internet, and the same computer's potential is indefinite. Intangible assets are more versatile than tangible in creating synergies. Brynjolfsson, Hitt, Yang, Baily, and Hall (2002) conclude that technology investment is complementary to organizational changes to succeed. This supports Christensen's (2018) ideas about the importance of organizational changes in digital transformation. N. Bloom, Sadun, and Reenen (2012) substantiates this by their results which indicates that European firms achieve inferior performance from tech investment because they are unable to change managerial practices. Haskel and Westlake argues that synergies matter "*because they create strong incentives for companies and governments to bring together different intangibles, especially new ideas*" (2018, p. 86).

### 2.1.3 Type of intangible assets

Haskel and Westlake argue that some of the most intangible-intensive firms are tech companies, but simultaneously emphasizes Marc Andreessen's words: "*it is not just about software: it involves other intangibles in abundance."* (2018, p. 23). Baumol (1966) and later contemporary described in Baumol (1996); describe a phenomenon where the cost of manufacturing is increasing slower than the cost of labour-intensive services. Economists call it Baumol's Cost Disease. Intangible assets are generally not developed by

manufacturing but by labour-intensive services; thus, Baumol's definition would experience a more excessive cost inclination. Furthermore, a considerable portion of intangible assets is dependent on information and communication. Therefore, information technology is an important measure to strengthen efficiency, which could explain why IT is commonly associated with intangibles. Working group at the OECD (OECD, 1998); Lev (2001); and Nakamura (2001) presents the same ideas of how to categorize the different types of intangible assets. C. A. Corrado et al. (2005) present a framework based on these proposals. They divide intangibles into three different groups: computerized information, innovative properties, and economic competencies. The first category, *computerized information*, addresses all types of information that a computer can utilize. Primarily this is applied to software and database development. C. Corrado, Haskel, Jona-Lasinio, and Iommi (2013) states that while computerized information has been included as an investment in the National Accounts since the 2000s, its relevance has not been weighted any importance before the introduction of terms like Big Data, etc. The second category, *innovative properties*, have historically been denoted as R&D. C. A. Corrado et al. (2005) claims that the conceptions should contain a broader definition and include momentums like mining exploration, artistic creations, and product designs. Haskel and Westlake (2018, p. 244) note that: "*the official definition of R&D relates to work to resolve scientific and technical uncertainty which excludes things like design and artistic endeavours*". Ryanair's inhuman designs of their airline seats, which grant them a competitive advantage through increased utilization rate, exemplify such innovative properties. The third and last category is *economic competencies*. C. A. Corrado et al. (2005) apply this category on momentums that does not fit in the two previously categories, but points towards three aspects in general: training, marketing and branding, and business process reengineering. These three subcategories are more focused on the managerial and organizational aspect of the firm and consists of intangibles that not directly are value creating but substantiates the firm's competitive advantage.

This section summarizes the rising concerns of intangible assets which derive from its properties. As intangible assets are a subject of definition, their properties might change on the basis of which accounting standards are applicable. While Haskel and Westlake discuss intangibles in an international domain, scholars like Lev and Gu, which will be covered later in this chapter, focus their analysis on the US market. Therefore, the following section will

review the general differences between the applicable accounting standards, which are covered through this thesis.

### 2.1.4 Accounting Standards

Accounting laws and standards differ between countries. Most countries have established a set of accounting laws set by a regulatory department. Accounting standards derive from said laws where the purpose is to assist each firm in aligning their accounting practices regarding the applicable legislation. This also ensures that each firm is following the same principles, which enable better comparability between each firm. Public companies in the United States follow the General Accepted Accounting Principles (GAAP) issued by the Federal Accounting Standards Boards (FASB). The equivalent standard internationally is the International Financial Reporting Standards (IFRS). Companies listed on the Oslo Stock Exchange are required to follow IFRS. The Norwegian accounting law states that "*the preparation of the annual accounts must be made in accordance with good accounting practice"* (Regnskapsloven, §4-6). The Norwegian Accounting Standards Board (NASB) publishes the Norwegian Accounting Standards (NRS) to assure this. This paper will cover all three accounting standards accordingly.

**Differences between GAAP and IFRS**

Both GAAP and IFRS defines intangible assets as an asset with the requirement that it is expected to benefit the organization for more than a year. Goodwill, which is recognized as an intangible asset, does not follow the same principles in regard to other intangible assets because of its non-identifiable properties. The most significant difference between IFRS and GAAP is whether intangible assets are expensed or capitalized. IFRS accepts that certain development costs are capitalized, whereas GAAP requires that development costs be expensed. Stuart (2020) states two central aspects between GAAP and IFRS regarding intangible assets: revaluation and internally developed intangible assets.

Revaluation of assets implies a change in the conceded price valuation of said asset. While GAAP generally prohibits revaluation, IFRS accepts carefully justified rationales other than impairment consideration. "*Intangible assets may be carried at a revalued amount (based on fair value) less any subsequent amortization and impairment losses only if fair value can be determined by reference to an active market" [IAS 38.75].*

Internally developed intangible assets derived from the firm's capacity to produce and utilize the corresponding asset. The associated costs of procurement are treated differently between the two standards, where IFRS [IAS 38.57] and Stuart (2020) states: "*Costs in the research phase are expensed as incurred. Costs in the development phase are capitalized if the entity can demonstrate all of the following*:

- *The technical feasibility of completing the intangible asset so that it will be available for use or sale.*
- *The intention to complete the intangible asset and use or sell it.*
- *The ability to use or sell the intangible asset.*
- *How the intangible asset will generate probable future economic benefits (the entity should demonstrate the existence of a market or, if for internal use, the usefulness of the intangible asset).*
- *The availability of adequate technical, financial, and other resources to complete the development and to use or sell the intangible asset.*
- *The ability to measure reliably the expenditures attributable to the intangible asset during its development.* "

As stated by Stuart (2020),

> "GAAP treats costs of internally developing, maintaining, or restoring intangible assets to be expensed as incurred when one or more of the following are true about the intangible asset: (a) it is not specifically identifiable, (b) it has an indeterminate life or (c) it is inherent in a continuing business or non-profit activity and relates to an entity. Given these restrictive criteria, the recognition of internally developed intangible assets is rare and usually only seen in the areas of patents and trademarks. Research costs are expensed as incurred."

The Norwegian Accounting Standard is essentially an extension of the IFRS standard with minor adjustments as required accordingly. NRS19 differs between two different categories of intangible assets: Identifiable and unidentifiable. The first variant can legally be displayed in the enterprise's financial statement and is categorized into four distinct areas: (1) *Research & Development*, (2) *Patents*, (3) *Derived taxes* (4) *Goodwill*. The latter value is strictly associated with the goodwill acquired from mergers and acquisitions, that is, the difference between price and net fair value of the company acquired. Unidentifiable

intangible assets cannot be legally displayed by financial statements and are often referred to as internally generated goodwill or inherent goodwill. It can be defined as a firm's excess value of the fair value price of its net separable assets. In other words, it is the difference between a firm's fair value and the firm's actual value. Due to this value being unidentifiable hence, non-separable, it is not visible on financial statements for a business.

The common ground between IFRS and GAAP regarding assessing intangible assets is that it requires caution. Evaluating intangible assets are a delicate matter because of their lack of physical structure. Both accounting standards take this into account. The reviewed literature will further in this chapter focus on the differences between the two accounting standards and essentially address the consequences of whether the related properties of intangibles are expensed or capitalized. The definitions stated by NRS19 are applicable when accommodating the Norwegian accounting data with the proposed methodology in Chapter 3.

### 2.1.5 Estimating value of intangible assets

The whole framework of this thesis is made on the background that assessing value to intangible assets is complicated. Previously mentioned research has proven that, although they tend to focus on the explanatory power of intangibles regarding the firm's market value. Haskel and Westlake (2018) denote that the major issue is how intangible assets are measured and, subsequently, applied to the business economic analyses. From an investor's perspective, are misevaluating intangible assets just another noise they must assess in their evaluation of a stock price. For a business owner, it is about existence or not. Intangibles might be considered as those elements that yield the firms its competitive advantage. Accurate estimating of those values is an essential component of the firm's strategic development to achieve superior competitive performance. Barth, Kasznik, and McNichols (2001) examine how market analysts allocate their focus regarding firms' type. Their research shows that there is a positive correlation that market analysts tend to focus more on firms with high intangible spending. This suggests a higher demand for third-part stakeholder that holds the ability to obtain disclosed information that is not retrievable from the financial reports. Consequently, this also indicates that the market does attribute the "hidden" intangibles some value. Further research is performed by Chen, Gavious, and Lev (2017), which directly could measure intangibles assets by comparing two different accounting standards. The US GAAP accounting standard requires that R&D be expensed in

the accounts, while the IFRS standard allows the design of R&D to be capitalized. The authors prove that the additional information retrieved from the capitalization of the design helped to predict the market value. Choi, Kwon, and Lobo (2000) address whether intangibles should be expensed or capitalized accordingly. They apply two different methods based on paired ranked tests and cross-sectional regressions analysis to measure the relationship between intangible assets, the associated amortization costs, and equity values. They conclude that the market positively values intangible assets and support the requirement that intangible assets should be reported in firm's balance sheet. Similar research have been conducted by Jennings, Robinson, Thompson Ii, and Duvall (1996), where they instead had a greater focus on the reporting of reported goodwill in regard to the market valuation.

### 2.1.6 Data as an asset

Unidentifiable assets are apparent in many shapes and forms and, measured by its prevalence, data are arguably the most neglected of those. Buzz words like "Big Data" are uncritically applied to articles and presentations of different thematic, without a comprehensive understanding of its implication on the established economic framework. Data should be understood as a compiled designation of various entities that provide the users with an understanding of its content through an information system. Accumulation of the data component in the economy is getting normalized simultaneously as individuals obliviously accept more of its generated data to be tracked and collected. Whether it is Google, Walmart, or Tesla, its competitive performance most likely can be denoted as its ability to utilize its gathered data from its customers/users. A study by Martin Bloom (2009) suggests that this ongoing trend is challenging the credibility of accounting in financial statements. The problem derives from businesses where data, as an unidentifiable intangible asset, is considered the firm's most significant value component. Bloom addresses the question of a legal change allowing data to be displayed on the balance sheet.

Facebook's market capitalization is approximately USD 444 Billion, while its book value of tangible assets amounts to $66 Billion (Cisomag, 2019). This implicates that roughly 85% of Facebook's value comes from sources that cannot be accurately identified. The significance of these numbers can be explained by Facebook's significant possession of data, which is per date, are not displayed in their balance sheet. These numbers raise the question of whether data should be included in financial statements due to their vital share and impact on a

modern enterprise's nature. One of the main arguments against this proposition is the ever-present asymmetric correlation between data and information, suggesting that data itself has no value if it cannot be efficiently converted into useful information. There is also a misconception about the importance of an enterprise's data where leaders tend to overestimate the actual value. Analyses on this argue that around 55 percent of all company data can be classified as "dark data", meaning it is unquantified or untapped and hence, useless (Hodge, 2019).

A make-up analysis from Bloom's article (2009), visualizing the components of the market capitalization of 400 companies on the ASX, suggests that 44,8% of all values derive from inherent goodwill. This number amounts to 52,5% for the top 50 listed companies. The other components consist of 25,5% net tangible assets, 7,6% identified intangible assets, and 22,1% purchased goodwill. When comparing these numbers to tech- or online platform companies like Facebook, with a corresponding number of 85% per 2019, it is evident to question if the current standard accounting limitations, which then in some cases only reflects 15% of a company's actual value, is sufficient. Hence, the idea of integrating intangibles such as data on financial reports could be taken into consideration.

## 2.2 Accounting

The core of this paper is the relevance of accounting regarding the intangible assets that exist within the firm. This section will address those accounting challenges, which entail the increasing amount of intangible assets. Briefly, these challenges can be categorized into two different segments. The first one regards the difficulty in including all the intangibles you are legally allowed to display. Some values are easily overlooked and hence creating gaps of potential value in the accounts. The issue is frequently referred to as misreporting of intangibles and is very common for larger enterprises. The second issue is related to accounting and the deterioration of the explanatory rate due to increased amounts of unidentified intangible assets. This will make it harder to draw information from the accounts to accurately predict the future stock price and make it harder for investors to operate on a safe level.

Additionally, this section is substantially influenced by the work of Baruch Lev and Feng Gu and their book *The End of Accounting (Lev & Gu, 2016).* Baruch Lev, professor at N. Stern School of Business, and Feng Gu, professor at the School of Management at the University

of Buffalo, have worked together on multiples topics regarding intangible assets and accounting. In their book, they apply four different tests which from different perspective indicates a continuous and steep decline in the usefulness of accounting information. The following sections will thoroughly explain each test and its results. Additionally, Jagannath and Koller (2013) presented a similar conclusion, focusing on the Generally Accepted Accounting Principle (GAAP) and how it fails to facilitate the financial reports' interpretability. Sherman and Young (2018) point in the same direction and argue that extensively using so-called "non-GAAP" measures is an increasing problem for interpretability.

### 2.2.1 Relevance of accounting

The first test by Lev and Gu evaluates the role of key financial indicators in determining the firm's market value. An interesting finding discovered before the test is that the fundamental information released in US companies' financial reports has not changed over the past 110 years. As recalled in the book, "… *there are absolutely no differences on the structure and information items provided to investors by the two financial reports" (2016, p. 1).* On the other side, the size and content of the reports have changed in some areas. Comparing the US Steel financial report from 1902 and 2012, shows a crucial development regarding the approach of presenting relevant information and the assessment of it. The 1902 edition is delivered through 40 pages and correspondingly 174 pages in the 2012 edition. This trend is also explained in the discussion paper presented by the International Auditing and Assurance Standards Board (IAASB, 2011). Despite the seemingly more informative financial reports, the research of Lev and Gu indicates the contrary.

The first test they propose aims to determine the relevance of critical financial indicators regarding the stock price. The increasing complexity of the financial reports speaks for an approach that "*... wisely choose a few summary measures, reflecting the essence of the financial report*" (2016, p. 32). Earnings and book values are two widely used indicators, e.g. Alexakis, Patra, and Poshakwale (2010) and Martinez (1999). Lev and Gu further argue that choosing earning as an indicator is favourable because it best reflects the firm's performance and the actual profitability during the period. Net income is applicable in two matters: a deposit to finance investments to strengthen future profit or to accommodate the shareholders by emolument dividends. Book value captures the firm's economic position and represents the value of the company. For example, Warren Buffet applies equity as an

indicator when considering key measures of operating performance in his annual Berkshire Hathaway report (see the 2020 Berkshire Hathaway shareholder letter). Additionally, since net income consists of revenues minus expenses, and equity consists of balance sheet assets minus liabilities. The two indicators also compromise a representative set of key financial information items widely used by investors. The stock price is then compiled and is further selected three months after fiscal year-end to assure that the market has had time to retrieve and analyse the information provided by the financial reports. Similar approaches are discussed in Kim and Zhang (2016); and Khan and Watts (2009).

Their research question was to answer: "*... how much of the variation in the market value is explained by, or can be attributed to, the set of explanatory variables?*" (2016, p. 33). They answer this question by performing a regression analysis over the data they retrieved from the annual financial reports and coherent stock price. The relevance of the financial indicators is thereby explained by the regression's adjusted coefficient of variation, its $R^2$ value. This test is performed on all available public firms in the US from the 1950s until 2013. The results display that in the 1950s, the relevance of the accounting information accrued up to 90 percent. By 2013 this number had eroded down to 50 percent. This is an indication that the usefulness of accounting has halved over the scale of 60 years. The contradiction here is that the seemingly more informative report from 2012 is less relevant than reports 60 years back.

To counter their results, critics have pointed out that earnings, in particular, are notably volatile and therefore insignificant reliable as a measure. Lev and Gu oppose this concern by performing the same regression analysis over additional financial key indicators: sales, cost of sales (implicitly considering the gross margin), SG&A, earnings, total assets, and total liabilities (2016, p. 35). This test returned a likewise results as to the initial examination. The $R^2$ value in the 1950s rode from 90 percent till around 50-60 percent in 2013. Both tests indicate the same phenomenon that financial reports implicitly understood as accounting information has lost its relevance.

### 2.2.2 Utilization of accounting information

In the 1940s, Claude Shannon and Warren Weaver developed an information principle central in information theory. Their research resulted in the 1949 *The Mathematical Theory of Communication* paper (Shannon & Weaver, 1949), where they provide a measure for the

amount of information transmitted by a message. They argue that the perceived assessment of the value offered by the information is subjective. Shannon and Weaver state that the information content is a function of what they call *newness of the message* perceived by the receiver. If it is presumed to rain tomorrow, the surprise of that message differs whether you are located on the west coast of Norway or in the Sahara Desert. The mathematical amount is measured by the logarithm of the ratio of the prior to the posterior probability of the event occurring. Lev and Gu, persuaded by this theory, applied it to their test of the relevance of accounting. As they denote, "*The fairly simple statistical methodology* [regression analysis] *cannot determine the extent to which the information in the financial report was surprising to investors. It only measures to what extent the information examined is consistent with the information impounded in stock prices.*" (2016, p. 42). What they are implying is that information that is not new to the investors does not affect the stock price. An example they use is if a company's income statement displays that earnings rose 20 percent from last year, and the financial analyst's consensus estimates in advance also was 20 percent, the company only met the expectations. There was no surprise, and therefore no new information and no reason to affect the stock price. Lev and Gu still explicit notes that the 20 percent earnings growth still would be correlated with the stock price, but not the trigger of the price increase. Thus, the usefulness of the financial information is dependent on its newness. Another perspective proposed by Hong and Stein (1999), strongly influenced by the information theory, argues that traders can be classified as "*newswatchers"* and "*momentum traders".* The former is more inclined to pay a high cost for gathering and understanding available information, whereas "momentum traders" rely on more easily interpretable information e. g., from the media or other sources. This is confirmed by Cohen, Gompers, and Vuolteenaho (2002), which found that institutional investors utilize reviewed information, and individual investors are more inclined to buy on price trends.

Lev and Gu utilized this discovery to continue their research of accounting relevance. A new test is applied to measure the financial report timeliness. This test is based on a research methodology known as an *event study*. It focuses on the primary information source available for investors and how they react to these information sources. Investors' reaction is measured by the stock price change from the exposure of information release. Lev and Gu select the following performance-related information sources, which are based on the same as proposed by Beyer, Cohen, Lys, and Walther (2010): Financial reports, other corporate SEC filings, analysts' forecast, and managers' forecast. The proposed question is: "*Relative*

*to the* nonaccounting managers' and analysts' forecast, and nonaccounting filings with the SEC, what was the unique contribution of financial report information to investors' decision?", (2016, p. 44). This means that if earnings reports are predicted by the analysts' forecast, investors would have reacted with a significant stock price change by the time of the release of the forecast. Thus, credited the stock price change to the forecast rather than to the financial reports. The test was performed on data from all publicly traded US companies in the time period between 1993-2013. The result they found were that in 1993, financial reports contributed to around 10 percent of the investors' information. Analysts' forecast contributed a bit less than that, and nonaccounting SEC filings were essentially non-existing. The result from 2013 cast light on a fundamental change in this dynamic. The financial reports contributed to around 5 percent, where both analysts' forecast and nonaccounting SEC fillings contributed to approximately 20-30 percent of the provided information. The 50 percent contribution of financial reports to the market value found in their first test is much lower based on the usefulness of that information. Similar tests were performed by Ball and Shivakumar (2008), where they concluded the following: "*... the average quarterly announcement is associated with approximately 1 percent to 2 percent of total annual information*".

### 2.2.3 Investors' irrational behaviour

The age of digital transformation got a slow start. Through the 1990s, numerous so-called "dot.com" start-ups acquired billions of investors' money based on vague but sensational business models and strategies. The consequences were inevitable, and the bubble burst and 5000 billion dollars weathered away. The dot.com bubble is a textbook example of the irrational investor, who undeniably overlooked the financial reports that showed notable losses on non-existent assets. This indicates that the previous finding of Lev and Gu might be a victim of such irrationality when previous results show that the usefulness of accounting has declined from 90 to 50 percent in 60 years. Could this be explained by an increasing irrationality by the investors leading the stock prices to rise, and subsequently wither the relevance of the financial reports? Lev and Gu performed an alternative test, independent from the investor's rationality through the stock prices.

Benjamin Graham writes in his book Security Analysis: Principles and Techniques: "*In the absence of indications to the contrary, we accept the past record as at least the starting basis for judging the future*" (Graham & Dodd, 1951, p. 425). Lev and Gu note that Warren

Buffet later refined this statement: *"... the long-term average of past earnings is an even better predictor of the future earnings of a business, since it smoothest out transitory fluctuations*" (2016, p. 53). To assess earnings' usefulness over time, Lev and Gu converge these thoughts through a simple expression. They take the last year's earnings, impose a percentage growth based on the average earnings growth rate over the past five years. This is the estimate for the current year's earnings. The forecast is then compared to the actual earnings, and a percentage error is calculated. The test is then finalized by averaging the absolute value of the forecast error over the entire sample. Additionally, another performance measure was included in the test, the more meaningful metric of return on equity (ROE). This test was performed on all public firms in the US from 1953 until 2013. To avoid fluctuations, the results are averaged over a 10-year successive period. Additionally, to avoid particularly volatile firms, those with a growth rate outside the -15% and +15% range are excluded. The results consist of two trends, one for estimates based on earnings and one for ROE. The prediction error based on earnings was in the first 1953-1964 period ca. 9 percent. Further, it shows that the trend is consistently increasing until the last period 2004-2013, which offers a prediction error at approximately 20 percent. Predictions based on ROE were more fit, and in the first period returned a 1 percent annual median, whereas the last period shows between 2.5 and 3 percent. The increase in the prediction error is similar for both types. These results are consistent with previous findings, but as Lev and Gu put it: "... *the prediction-based evidence of this chapter doesn't rely on investors' understanding and correctly using financial information*" (2016, p. 55). Similar results are documented in a more comprehensive empirical study by Lev, Li, and Sougiannis (2010). Lev and Gu point at the FASB's *balance sheet approach*, adopted in the 1980s, which states that the objective of accounting is to valuate assets and liabilities at fair values. This leads to the firms being required to include *one-time items*. Primary expenses that do not recur in future periods strongly limit the ability of reported earnings to reflect the firm's performance. Lev and Gu traced the ratio of one-time entries in the accounts from the 1950s until 2013 and found that the percentage ratio increased from 2 to 17 percent. As they conclude, "*Many of the losses reported by companies are due to accounting procedures that don't really reflect a permanent deterioration of business fundamentals…*" (2016, p. 56).

### 2.2.4 Disagreement between investors

The last test Lev and Gu performed was directly aimed at the degree of consensus between investors, or likewise lack of such. Most public companies are followed by numerous financial analysts whose job is to specialize in that specific firm's industry and market. The size of the firm matter, and larger firms tend to occupy more followers. Each analyst usually follows a subgroup of 10 to 15 firms within a sector and is subsequently considered experts within their fields. The type of information and their sources the analysts utilize might differ between each analyst. Different models proposed by, e.g., Harrison and Kreps (1978); Scheinkman and Wei (2003); and Hong, Scheinkman, and Xiong (2006) confirms that investors attach different interpretation from the same information source. The fundamental core of the information is still the firms' periodic financial reports. However, and as it has been demonstrated, accounting and, subsequently, the financial report is complex. The interpretation of the financial report would most likely be different because of the mixture of facts and estimates. For example, consider produced cars, number of customers, oil wells, etc. They are hard facts and cannot be interpreted in different ways. Earnings, on the other side, consists of a combination of certain facts and estimates. The financial analysts have to asses earnings and additional available information to determine its usefulness of their predictions. This is consequently rooted in the presentation of different predictions amongst the analysts and the degree of consensus or disagreement. Lev and Gu used this as the basis for their last test to answer the following question: "*Is the work product of financial analysts, who rely on accounting information, improving over time?*" (2016, p. 61). To quantify disagreement, they addressed the dispersion between the analysts' prediction by measures like, for instance, the standard deviation. Looking at a five-year median interval, the test showed that there is a steady increase over 37 years of the standard deviation around the consensus between analysts regarding their predictions.

In conclusion, these past research sources indicate that accounting, especially within the area of intangible assets, is facing some issues on the long term. The methodological approaches behind previous research have been a source of inspiration which helped forming this thesis. In the next chapter, our approach and research design will be presented.

# 3. Methodology

The experiments presented by Lev and Gu (2016) have been the core inspiration for our research and through this chapter, the methodology will be developed in consistent with them. Additionally, the experiments of Choi et al. (2000) is implemented along a final experiment developed by the authors themselves. In the following sections a comprehensive review of the proposed research design and strategy are presented. Followed by a general clarification of the key concepts within statistical analysis which are included in the proposed models. The last segment of this chapter consists of a review of the developed methodology embodied by four experiments. Weaknesses and the strength of this design will also be discussed in terms on focusing on validity and hence making the research more solid and trustworthy.

## 3.1 Research design

The area of research has previously been addressed from several different angles, but due to its complexity both in definition and content, different approaches will be applied in cross-combination to establish empirical magnitude for our thesis. The research will be of *deductive* nature, following a *descriptive* approach by studying the impact and development of intangible assets for Norwegian companies, both listed and non-listed on the Oslo Stock Exchange. Additionally, the data will be gathered and utilized quantitatively by analyzing numerical information through statistical and computational techniques. The explanatory properties, subsequently deriving from the assessment of the Norwegian market, initiate that the purpose of this research is *descripto-explanatory*.

Quantitative methods enable the research to address a larger sample of subjects with fixed variables, signifying its ability to generalize findings with a high degree of accuracy. Methods are usually efficient and offer a more precise potential for replicability. Contrary to qualitative approaches, quantitative methods are well suited for detecting trends, conducting forecasts, and claiming significance in numerical relationships (DeVault, 2020). The downside of quantitative methods is the limitations correlated with the pursuit of concrete evidence, leading to an overemphasized, misleading focus on numbers. Subjectiveness can increase bias in the results and further deflect the researcher from looking at the bigger picture, falsely claiming significance in a hypothetic causal relationship.

## 3.2 Research strategy and objective

A European Commission has released a study that perceives Norway as one of the countries that receive the highest score on The Digital Economy and Society Index (DESI, 2020), which summarizes relevant indicators regarding the degree of digitalization each country has achieved. The DESI index intends to evaluate and compare each country's digital competitiveness. Multiple literatures have thoroughly covered the relationship between an ever-increasing degree of digitalization, technological progression, and intangible assets. This research aims to develop the methodology from previous researchers to examine this relationship in context with a selection of Norwegian firms and the local condition that might deviate from the previous research.

Through the last two centuries, the Norwegian economy has been denoted as a period of stability and growth. Although the financial crisis in the period between 2008-2010 had a negative impact on this trend together with the weaker interest level through the oil crisis, the Norwegian economy has managed itself well. An important measurement to determine the condition of the economy is to review its total production. The core of this operation has been the accounting information for all Norwegian-registered firms, which are initially obtained by the Norwegian tax authorities. Simultaneously it exists a requirement that each company must report their financial figures in accordance with the applicable accounting laws and regulations. Admittedly if the firm is accountable. This relationship forms the basis for two critical factors: Firstly, Norwegian authorities are dependent on the reported accounting figures to further measure and calculate the GDP and the general condition of the economy; secondly, the firms are responsible for evaluating and reporting these figures. Lev and Gu (2016) denote multiple times that a model where the firms themselves stand free to estimate their asset always will contain probability for deviation. It is essential to state that this deviation could occur as a result of inaccuracy or intentionally. This is partly due to the nature of intangibles as something complicated to valuate and that the company itself is in the best position to assess by the cost of its acquisition. The consequence this conveys is a more rigorous accounting regulation that limits what intangibles to include, in addition to whether it should be capitalized or expensed. This thesis bases its assumption that these consequences prevent the company from capturing its intangible assets' actual value, thus resulting in inaccurate reporting to the authorities. The consequences can be divided into three different levels: [1] the tax authorities utilize inaccurate figures to assess GDP; [2]

investors receive inaccurate estimates of their valuation; [3] the firm itself risks a misconception of their competitive advantage. The last level is marginalized by the literature when the focus tends to be directed towards investors' and authorities' interests. The objective of the methodological procedure, which will be reviewed further through this chapter, is to answer whether intangible assets are inaccurate assessed and what consequences this arise regarding the three previously mentioned levels.

Multiple experiments will be utilized to successfully achieve *triangulation*, which is, the practice of using various approaches to accomplish indications towards the same answer and broaden the perspective and scope of the research ("Encyclopedia of Research Design," 2010). All methods have deductive characteristics, trying to enlighten different aspects of intangibles with the theoretical background from previous researchers' findings. The literature review mainly examines international markets such as the US or Australia to prove specific trends. Our research will be applying methods inspired from those studies, but for the Norwegian stock market, the OSE. The core experiments will have slight alterations in order to enlighten certain aspects of importance that are not easily caught up in previous research. Additional new experiments will also be conducted to supplement our findings, aiming to unveil valuable information presented as indications of significance.

The essence of this study consists of examining two conditions that can be derived by dividing intangible assets into two segments, identifiable and unidentifiable. Two experiments will be applied to assess unidentifiable intangible assets. This is done by examining two experiments originally proposed by Lev and Gu (2016). The first test consists of adapting a regression analysis where selected key financial measurements explain the company's market value. Eventual differences would indicate that the information retrieved through the accounting figures alone is not enough to determine the market value. Thus, the results will explain to which degree any information is either not captured or inaccurately reproduced in the accounts. A resembling experiment proposed by Lev and Gu utilizes the firm's growth rate as the premise to estimate future earnings. This test intends to determine the suitability of the accountings figures to estimate performance without considering the assessment of the market value, which might be inaccurate for different reasons. These tests will, by themselves, not be enough to determine a relationship regarding intangible assets. The following two experiments intend to assess the identifiable intangible assets, that is, the intangibles that can be legally displayed in financial statements mentioned cf. "NRS19-Intangible assets" under the literature review. In consistent with Choi et al. (2000) and their

Balance Sheet Hypothesis, the third experiment is adapted by two tests. The first one intends to compare three test portfolios against selected key calculated measurements for both earnings, equity, and market value. The second test adapts a regression analysis with basis in the same measurements to determine its explanatory power regarding the market value. The purpose of these tests is to assess to which degree the identifiable intangibles affect the firm's performance and its market value. In the fourth and last experiment, we investigate the amount and development of unidentifiable intangibles, subsequently often labelled as inherent goodwill. The cross-sectional examination of both types of intangibles should enable us to find patterns with similar traits to those of previous research, potentially discovering new aspects to the trend, supporting our research question and hence adding empirical evidence towards the need for change.

## 3.3 Data Collection

Collecting reliable and relevant data is essential when conducting quantitative research. Concerning this, it has been of the highest importance to retrieve data from trustworthy sources and minimize the risk of merging multiple data sources. In this thesis, we distinguish between primary and secondary data.

### 3.3.1 Primary data

Following our research's quantitative and descriptive design, accessibility to more extensive databases would be beneficial to ensure a credible foundation of raw data. Taken this into consideration, this thesis will primarily rely on data from SNF and Oslo Stock Exchange. SNF is a company cooperating with the Norwegian School of Economics which aims to organize and execute externally financed research. Students can gain access to their database by applying through email. The database contains accounting information on all registered Norwegian firms from 1992 to 2018. For our research, we have been retrieving accounting data from this site. A more descriptive overview of this data can be examined in the appendix [1]. Oslo Stock Exchange is Norway's official platform for trading stocks and securities. Their official page offers structured information on stock prices, indexes, options and basically all key figures regarding financial development in this area for listed companies. This data is considered public and can be retrieved in excel format from their websites (Oslo Børs, 2021). The downloadable content ranges in the time period from 2002-

2019. From this site, the only variable retrieved is the market capitalization for all listed companies in this range of time.

Accounting data, with the slight exception of the usage of estimates, usually displays more or less precise information, which an auditor for larger companies controls, suggesting that the information should be relatively stable with a high degree of credibility. On the other hand, stock information is more prone to changes caused by predictions and, hence, fluctuates more. For the experiments emphasizing identifiable intangibles, accounting data is the most valuable resource giving direct information on some of the variables under investigation. Including a calculated market value might also be useful in creating a broader perspective on the effect of financially stated intangibles. For the experiments focusing on inherent goodwill, we aim to unveil the development of certain values that are not captured on financial statements, making it challenging to find significant results solely by examining financial accounts. Here, stock info, mainly for finding the market capitalization, is extremely valuable in combination with accounting variables in order to detect the amounts of inherent goodwill. Summarized, the primary data consists of accounting data and stock data. The cross-combination of these data sources enables us to discover patterns between accounting information and market valuation, which may be significant in our area of research. This combination also lays the vital fundament in the conduction of experiments used in this study.

### 3.3.2 Merging market data and accounting data

A central element of this study is to examine how accounting information affects the firm's market valuation. In that regard, will the compilation of the market value and respectively accounting information be a critical factor before tests can be performed. The market valuation for each company is, as denoted earlier, retrieved from the Oslo Stock Exchanges (OSE) databases, while the accounting data is retrieved from SNF. To accomplish the compiling of data sampling from two different sources, some common identification variables are required to identify the same firm in both data sets.

Data from OSE contains a unique company ID for each company listed on the stock exchange and can further be compounded with coherent organization numbers. Accounting data from SNF contains both organization number and name for each enterprise as possible identification variable. Primarily, the organization numbers have been used through the work

of compiling the data. However, this has led to two precarious problems. The first one is that the organization number is absent for some companies and thus prevent compiling with this identification variable. This has been solved by manually going through each company with missing IDs and attempt to compile using the enterprise name instead. The challenges that arise with this method is that some companies might change name between years. Additionally, the applied software used for the data analysis does not handle the Nordic letters that some companies' names possess, which further complicates the compiling process. At last, the challenge around subsidiaries also impacts this process, where the name of the listed firm group is similar to its subsidiaries which are also included in the accounting data. The second problem faced through this process is that some listed companies on OSE are not registered in Norway and, consequently, do not possess their own organization number and thus are not included in the accounting data. These are excluded from the sample data.

### 3.3.3 Industrial Classification

Each firm from the SNF accounting data is categorized by a standardized industrial classification. Norwegian firms follow the SIC standardization issued by Statistics Norway (SSB) (2009). The time perspective for this study covers the year 1999-2018, and for this period, three different SIC standards have been active: SIC1994, active from January 1994 to January 2002; SIC2002, active from January 2002 to January 2009; SIC2007, active and still valid from January 2009. Data from SNF only includes SIC2002 and SIC2007, which are compiled with companies prior to January 2002. However, the earlier years have lower coverage of the SIC codes which means that there are more firms where the industry code is not present. For the years 1999-2008, this study uses the SIC2002 classification and then SIC2007 for the years 2009-2018.

### 3.3.4 Excluding non-profit maximizing firms

Companies that exhibit non-profit maximising or non-competitive behaviour affect the test in this study negatively. According to an earlier master thesis authored byRatvig and Svergja (2016), these firms operate in industries that tend to be heavily subsidized, high tariff barriers, or operate in markets where normal competitive behaviours are absent. A selection of firms affiliated with coherent industries is excluded from the test data by the following two-digit NACE found in the appendix [2].

### 3.3.5 Secondary data

Secondary data uses external sources to supplement our research, such as theoretical backgrounds and findings from the literature review section. By doing this, we can effectively expand the extent of triangulation in the research to strengthen credibility. Secondary data usage is of utmost importance for our study due to two factors: the nature of quantitative research and the uncertainty regarding this field of research. The previously mentioned flaw of quantitative research concerning an excessively focus on numbers is highly relevant here. When finding a correlation, backing it up with legitimate findings from the previous study that supports that correlation may enhance trustworthiness. The field of research is broad and vague, implicating results can leave room for interpretation. Regarding the topic of intangible assets, this is a vital concept. This especially applies to the category of intangibles that cannot be legally displayed, the unidentifiable ones. Any result involving these variables might require further interpretation due to its broad definition, which ultimately can result in a misleading conclusion. The usage of secondary data sources can assist in closing this gap of potential subjective errors and play a crucial role in forming a conclusion in our research.

## 3.4 Analysis approach

Results deriving from quantitative methods alone can be quasi-optimal without a corresponding analysis and discussion when investigating the area of intangible assets, again, especially the unidentifiable ones. To gain a complete understanding of the results, we need to analyze thoroughly to unveil potential areas that can be misleading for our statistics. Coefficients, $R^2$, p-value, and regression outputs, will be discussed and compared to secondary data sources. Results displaying low levels of significance will also be analyzed from different angles to discover potentially hidden patterns that external factors can bias in our data. The essence of this study is not based on raw quantitative results but on the complete interpretation and discussion around them.

### 3.4.1 Data Weakness

The two databases contain different amounts of observations, roughly 300 000 per year for SNF and approximately 200 for OSE per year. Some of these observations are blank, meaning it was necessary to clean parts of the data and coding to sufficiently conducting the

intended experiments. Within the total time frame of 1999-2018, numerous companies merged, disbanded, or changed their names, making it difficult to track the entire development of particular enterprises. Hence, the most representable and stable timeframe for our OSE data was between 2010-2018, which is not a considerable size, but big enough to prove significance in our area of research. Despite this being a relatively small range to investigate, it is arguably one of the most interesting periods to examine due to the effect of digitalization within those years. Furthermore, it is evident to address this research's credibility, validity, and reliability when assessing potential weaknesses.

### 3.4.2 Credibility

Credibility is an essential concept within research and revolves around whether the research is trustworthy based on literature, methods, and discussion. The research conducted in this thesis mainly aims to highlight clear indications of a trend. Presented findings point in the same direction as those depicted in previous research in this specific field, arguing for a solidified claim towards supporting our initial thought concerning the necessity of changes to the current reporting standards. We have been utilizing data from two reliable sources with a high level of credibility to create comprehensive methods yet do not require the highest level of sophistication. In terms of credibility, a systematic and transparent literature review, consistent and appropriate methodology should make this research trustworthy.

### 3.4.3 Validity

When reviewing the concept of validity, different perspectives are affecting the credibility of the conducted research. Saunders, Lewis, and Thornhill (2019) define validity as "*the appropriateness of the measures used, accuracy of the analysis of the results, and generalizability of the findings…"* (p. 214). The validity of the developed methodology is induced by its capability to produce reliable and accurate results. Saunders et al. (2019) further refer to three central properties deriving from their initial definition: *measurement validity, internal validity*, and *criterion validity*. The last properties, criterion validity, are usually applicable for questionnaire-based studies and is therefore not relevant for this paper.

**Measurement Validity**

This aspect is associated with if the included measurements of this research are capable of achieving its cause, explicitly answering the proposed research question. The complex properties of the research question are often proposed more extensively, making it difficult

to find specific methods that can efficiently measure the entire problem at once. Therefore, the approach presented in this study has been constructed with the intention of measuring smaller entities of the imminent subject. The included measurements are retrieved from the reviewed literature and cautiously implemented in this study. This returns acceptable confidence in the measurements in order to address the research question.

Another aspect relevant for the measurement validity is the properties of the proposed experiments conducted in this research. The proposed research question introduces uncertainty about whether the current accounting practices are relevant in explaining the proficient performance of individual enterprises. The established methodology intends to identify attainable evidence that the validity of the included measurements regarding the performance is diminished. Consequently, the methodology must assert the validity of the conducted experiments in addition to the properties of the measurement validity.

**Internal validity**

To which degree the findings from this study truly address this research's intervention are determined by the internal validity. The explanatory properties of this thesis indulge the application of experiments with the intention of measuring the relationship between one or more variables. This consequently involves an examination of the concept of causation. As stated by Nate Silver in his book *The Signal and the Noise (2012, p. 186):*

> "*With so many economic variables to pick from, you're sure to find something that fits the noise in the past data well. It's much harder to find something that identifies the signal…"*

The likelihood of encountering correlation between variables consisting of economic figures is prominent. Assessing this relationship without considering the causation of this correlation would directly affect the ambiguity of the causal direction for this study. Proper preparation in advance, including correct assessment of the retrieved data and adjusting for inflation, minimize the endangerment of inaccurate measurements. Each experiment is performed to assert the significant correspondence between the incorporated variables, consequently minimizing the inflicted bias by appropriate countermeasures. In the chapter of discussion, numerous perspectives are investigated to eradicate the possible ambiguity of the causation.

### 3.4.4 Reliability

Reliability revolves around the idea of the accuracy of the research, usually revolving around the question of repeating the experiments several times would give the same results. The study is based on accounting numbers and public stock information quantitatively, which naturally makes it strong in terms of reliability. The types of data should be accessible for most stock exchanges implicating that the replicability of this study should be easy for future researchers. One factor that potentially challenged the reliability of this research is the timeframe of investigation. When operating with a small range of years, 2010-2018, the research is vulnerable to major external factors biasing the results. For this study, the oil crisis of 2014 had a significant impact on our numbers. However, a countermeasure was applied by focusing on unaffected data, giving us the same indications. Repeating these sorts of experiments for any stock exchange within a timeframe of a suitable size that does not include any major crisis is likely to give the same results as those found in this study - results can be generalized.

### 3.4.5 Regression Analysis

A repeating procedure in this study is the utilization of multiple regression analyses. The purpose of performing a regression analysis is to discover the true relationship between one or more independent variables against a dependent variable. The dependent variable is often denoted as *Y* and is further called the response variable. The independent variables are thus denoted as *X* and are referred to as either predictors or explanatory variables. Best fits are calculated by finding a function which is a mathematical explanation of the relationship between the predictors and the response variable. This equation can display multiple structures, depending on whether one is required to identify a simple linear regression or a multiple linear regression. The predictors' variables can also take the form of quantitative and qualitative values, which further alters how the equation functions and appears. The most commonly applied regression analysis is denoted as *Ordinary Least Square* (OLS) and in the multiple regression condition,  and James, Witten, Hastie, and Tibshirani (2013) denotes the equation as the following form:

*Equation 1*

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p + \epsilon$$

This model shows how a change in the $X_p$ variable causes a change in the Y variable using the beta value $\beta_p$. The point of intersection to the Y-axis when X is equal to zero is denoted by the $\beta_0$ value, which is constant. Further, the beta coefficient $\beta_p$ determines the $X_p$ variable's size and thus decides the importance of this predictor variable. If the $\beta_1$ are approximately equal to zero, in relation to the value of Y, a change in the tested predictor causes little or no change in the response variable. Also present in both models is the ε-value, which acts as an axiom for the mean-zero random error term for the model. This is based on the assumption that the model contains no errors but simultaneously considers that the model is not a perfect fit. Like the recognized professor Goerge E. P. Box (1987) states, "*Essentially, all models are wrong, but some are useful."*[p.424]. Consistent with James et al. (2013), the OLS regression involves minimizing the least-squares criteriums. This means choosing estimated $\beta_p$ values, which in turn minimize the residual sum of squares (RSS). In practice, one implements a hypothesis test when performing an OLS regression, where the null and alternative hypothesis are as follows:

$H_0$: *There is no relation between Y and X.*

$H_a$: *There is a relation between Y and X.*

$H_0$ test whether $\beta_p$ are equal to zero, while $H_a$ tests whether $\beta_p$ are not equal to zero. Further are a *t-statistic* calculated, which measures the number of the standard deviation that the estimated $\beta_p$ is from zero. With the foundation from the t-statistic, the *p-value* can be read and thus determine whether $\beta_p$ is equal to zero or not. The accuracy of the regression model can be measured, among others, by the assistance of the *residual standard error* (RSE) or $R^2$. Implications with utilizing RSE to measure accuracy is that the calculated value takes the basis of the value of the response variable, and thus the result would vary between the experiments depending on which response variable one fits the model after. Alternative one could calculate the $R^2$ value, which measures the linear relationship between the Y and X variables. The $R^2$ value will always be a number between 0 and 1, and the value gives an indication of how much the change in Y can be explained by a change in X. For this study, it is appropriate to fit an OLS multiple linear regression analysis on the examined values. Likewise, would $R^2$ be an essential parameter to address the pending research question for this thesis.

### 3.4.6 Criteria for an Unbiased OLS Regression

The OLS regression analysis performed in this study attempts to explain a real-world occurrence by different sets of variables. A fundamental component of any statistical approach is the never-ending balancing between the *bias-variance trade-off*, which is, as stated by James et al. (2013), decomposed into the sum of three properties: variance, squared bias, and an error term. The variance is referred to as the amount an estimated value would change between different training data set. Attempting to approximate a real-life problem by fitting a linear regression analysis would undoubtedly introduce bias. This derives as a natural consequence that real-world problems include numerous different factors that affect the results. To measure all of these into different variables for the regression analysis is realistically not feasible. The predicaments introduced by the bias affect the analysis by returning the best fit that does not accurately estimate the response variable. To ensure an unbiased OLS regression, five assumptions, commonly referred to as the Gauss-Markov assumption, are controlled. These are listed as follows:

**Assumption 1: The regression model is linear in the coefficients, and the error term**
This assumption refers to the characteristics of the regression model and that the coefficients are either constant or a size-wise explanatory power for the independent variable. Regarding the OLS regressions in this study, one can assume that the coefficients satisfy these requirements and consequently does not affect the results.

**Assumption 2: The tested dataset is based on a random sampling of the population**
The datasets involved in this study are thoroughly reviewed, and test objects are extracted in accordance with the current literature. This selection process is not supported on the basis of random sampling, however, strict requirements ensure test objects that consist of a representative selection of Norwegian firms. Some biases are likely to be present as a result of this sampling method.

**Assumption 3: The collinearity between the independent variables is non-existent.**
Multicollinearity refers to a situation where two or more independent variables are related to each other. This might arise an issue regarding this thesis, where preliminary tests have suggested that this is applicable. When performing regression analysis on economic values, multicollinearity appears when two values are related to each other, such as earnings and equity. Firms with substantial revenues will most likely be consistent with the company's size, and consequently, its equity. Therefore, it is natural to think that earnings will fluctuate

with equity. A collinearity matrix will be used to identify possible collinearity problems, and an *interaction term* would be implemented as a countermeasure.

**Assumption 4: The error term has an expected value of zero**

This study would most likely experience bias derived from the expectation that the error term would not be equal to zero. Within the definition of the pending research question for this thesis is the assumption that the independent variables cannot explain the response variable. Consequently, that the error term is not equal to zero. Regarding this prerequisite, the error term should be minimized to the best extent by implementing the same variables that are covered in the literature review.

**Assumption 5: The error terms are homoscedastic**

The last point determines whether the error term has a constant variance (homoscedastic) or not (heteroscedastic). The preliminary test indicates that issues regarding heteroscedasticity are unlikely to affect the regression analysis. Each test result is visually examined through scatterplots of the residual, and the Breusch-Pagan Test is performed to test from statistically significant heteroskedasticity. Halbert White introduced a potential countermeasure to heteroscedasticity, utilizing heteroskedasticity-consistent standard error, commonly referred to as robust standard error.

Assessing the assumption above, the regression analysis performed in this study would most likely experience some bias. However, this is minimized by addressing the sources for where bias might occur and implement adequate countermeasure.

### 3.4.7 Wilcoxon Signed T-test

Further in this research, the Wilcoxon signed t-test is implemented to compare matched data samples. This method was proposed by Frank Wilcoxon (1945) and is widely used as an alternative to the generally known *paired Student's t-test*. As denoted by Xia (2020), the Wilcoxon signed-rank test is preferred when the sample data does not follow the normal distribution. The normal approximation to the signed-rank test is to test the hypothesis that the difference between two equal samples has a median of zero. The null and the alternative hypothesis are denoted as:

$H_{0:}$ *The median difference between the matched pairs follows a symmetric distribution around zero.*

$H_a$: *The median difference between the matched pairs does not follow a symmetric distribution around zero.*

The procedure of the Wilcoxon signed-rank test is to rank the absolute value of the calculated difference between the matched sample pairs, from the smallest to the largest. The test statistic is then calculated by the following mathematical equation:

*Equation 2*

$$W = \sum_{i=1}^{N_r} [sgn(x_{2,i} - x_{1,i}) \cdot R_i]$$

The $x_2$ value is the "new" value, where $x_1$ naturally is the "old" value of the matched pair. This difference is then multiplied with its rank, denoted by $R_i$. Lesser differences will consequently be lower weighted than more considerable differences, resulting in a more prominent test statistic. Reviewing the relevant significant p-value determines whether the alternative hypothesis is either accepted or rejected.

To assure satisfactory result, three main assumptions should be met for the signed-rank test. First and foremost, the data are paired and from the same data sample. Second, each of these pairs are selected by the basis of random sampling. Third, the data are measured following either an interval scale or an ordinal scale. According to this study, the data is paired year-wise and by industry and selected from the same data sample. Because of insufficient observations, matching each firm size-wise was not feasible. This might presuppose the inaccuracy of the signed-rank test; however, these differences provide a foundation for further discussion resolving the explanatory characterization of the market dynamic. The signed-rank test is performed on all available matched pairs and is divided by an ordinal scale where a sample condition is represented according to the test portfolio presented by Choi et al. (2000).

This test can be conducted following two different methods; the Wilcoxon signed t-test and the Student's t-test. A prerequisite for the Student's t-test is that the sample data follows a normal distribution. The matched sample pairs in this study are tested for normality by implementing the Shapiro-Wilk test. A null hypothesis is based on the assumption that the sample data follow a normal distribution which is represented by the following test statistics:

*Equation 3*

$$W = \frac{(\sum_{i=1}^{n} a_i x_{(i)})^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

A lower p-value indicates that the sample data does not follow a normal distribution. Preliminary tests indicate that the sample data in this study does not follow the normal distribution, and therefore the Wilcoxon signed t-test is implemented.

## 3.5 Methods

Four different experiments are performed to assess the initial research question and are further divided into addressing two various aspects. The first two tests are developed based on the work of Lev and Gu (2016), and its intention is to address the usefulness of the accounting figures. This is based on the observed phenomenon that the financial reports tend to be less informative because most accounting figures fail to capture intangible assets' actual value. The purpose of the first test is to evaluate how the market interprets the information retrieved from the financial reports by predicting the market value of each public listed firm. The second test is developed to address the same issue, but by assessing the explanatory power of the financial reports to estimate future earnings. The second aspect consists of attempting to determine the valuation of intangibles assets by performing two different tests. The first test is based on the work of Choi et al. (2000) and consists of a cross-sectional analysis between firms with and without intangible assets that are already captured in the accounting dataset. The last test aims to address intangible assets that are *not* included in any financial reports.

### 3.5.1 Previewing Experiment 1: Market Value Hypothesis

The purpose of the first experiment is to examine the relevance of financial reports regarding assessing firms market value. In line with previous research, which concludes that the relevance is declining, a similar approach is applied to a selection of Norwegian firms. This test intends to return an indication to which degree the financial reports explain the market valuation of a company. The results from this test are attempting to describe the importance of the information, which is known by the market but is not captured through the financial report. If the thesis about increased misreporting of intangible assets is correct, this will affect the result of this test. It is specified that this test would not directly apply insufficient

valuation of intangibles as an explanatory variable. Within a market where the investors apply more value to the financial figures, this test will return a higher explanatory power to the selected measurement from the financial report. This may be due to good and precise accounting principles within the selected country or the absence of relevant information. The Norwegian market should be considered with high confidence to the legislators and associated accounting laws, including a high degree of transparency regarding access to pertinent information.

**Test Portfolio**

The test portfolio consists of all public listed companies on the Oslo Stock Exchange (OSE) where the market value is available. Accounting data from SNF is applied to these companies. The historical market value is limited to the years 2010-2018. Some listed companies on OSE are, for different reasons, not possible to attach to comparable accounting data and are therefore excluded from the portfolio.

**Variables**

The market variable acts as the dependent variable in this model, where the financial measurements are the independent variables. This model aims to study the probability of a change in the financial figures causing a change in the market value, consistent with Saunders et al. (2019). Lev and Gu (2016) apply two different financial key measurements to their research, reported net income (NI) and the book value of equity (BE). Choi et al. (2000) apply earnings before extraordinary item (EBX) as an alternative to net income. This model implements NI and BE as independent variables, including the number of shares outstanding (NHS).

*Net Income variable (NI)*

The net income is generally calculated as all sales minus the coherent cost of goods sold, general and administrative expenses, amortization costs, interest and taxes, and other expenses not directly related to the operation of the firm. Net income is a valuable indicator of how well the firms' profitability is and to which degree they manage to cover the organization's expenses as a whole. However, net income should not be assessed by itself. A $100,000 incomes statement might be two different stories for a multinational organization and the local barbershop. How well it is an explanatory factor depends on which context the figures are calculated with. Compiling net income together with other measurements like the number of outstanding shares or equity improves the understanding of the condition for the returned figures. Applying net income as a predictor variable for the market value is relevant

because it explains to which degree the market valuates the profitability of the firm. However, and as Lev and Gu (2016) denote, reported earnings are a subject of manipulation and estimates. Ruling accounting law allows to some degree the inclusion of estimates in the income statement (Regnskapsloven, §4-2):

> *"In case of uncertainty shall best estimate be used, by means of the information that are available at the moment the accounts are reported."*

This is especially applicable to firms with a high degree of intangible assets where its cash flow are complicated to pinpoint exactly. The uncertainty regarding the accuracy of the reported income statement will to some extent, affect the impact of the reliability of the regression analysis. This will further reinforce the exploring issue of the relevance of the accounting figures regarding the market value.

*Book value of common equity variable (BE)*

Equity represents the value of the firms' total assets minus liabilities and is often denoted as a company's book value. Therefore, equity is a good indicator of the values that the company owns and controls by itself. Companies with a high degree of equity control either a substantial amount of assets or have few liabilities and are perceived from an investor's perspective positively. Firms with a low or negative degree of equity are considered as investment objects with less appealing risk. The formula to calculate the book value of equity is considered as follows:

*Equation 4*

$$BE = Total\ Assets - Total\ Liabilities.$$

*Number of shares outstanding variable (NHS)*

Share's outstanding is the number of stocks that the firms' shareholders currently hold. This number fluctuates as the company issues additional shares, typically when raising capital through equity financing. These figures are retrieved from the firms' balance sheet and are included in this model as a control variable to understand better how the earnings and equity are distributed.

This experiment's intensions are to determine whether the proposed alternative hypothesis is applicable for the selected test portfolio:

H1: *There is a relation between net income, equity, and the number of outstanding shares regarding the market valuation.*

**Model**

The general specification of the model:

*Equation 5*

$$MV_{it} = \beta_1 + \beta_{2t}EBX_{it} + \beta_{3t}BE_{it} + \beta_{4t}NHS_{it} + e_{it}$$

**Analysis**

Annual cross-sectional regression analysis is performed on the portfolio, and the adjusted $R^2$ is obtained for each year. The adjusted $R^2$ is, in this context, understood as the explanatory power of the financial figures regarding the market value. The significance of the predictor coefficients is examined to determine whether the null hypothesis is rejected, consequently accepting the proposed alternative hypothesis.

### 3.5.2 Previewing Experiment 2: Earning Estimate Hypothesis

The purpose of this experiment is to determine whether the booked accounting figures form a basis to predict future earnings for a given firm. The intangible amortization costs should be included in the total amortization cost of all assets (both tangible and intangible) within the firm by the Norwegian accounting principles. The booking of intangible assets would therefore affect the amortization cost and further affect the firms' earnings. If there is a significant deviation between estimated earnings and the reported earnings, this may indicate that the explanatory power of the financial reports is impaired and the differences attributed to other factors that are not captured in the accounting. This test does not uncover whether missing interpretation and reporting of the actual value of intangible assets is the cause but rather measures the general robustness of the financial figures. This is an alternative to the first test by excluding the investors' interpretation, which might affect the firm's market value, and thus, this test acts as either a countermeasure or support to the initial results of the usefulness of accounting.

**Test Portfolio**

A test portfolio consisting of all Norwegian firms that are required to file their accounts are created. The data is retrieved from the SNF accounting data. Two limitations are ruling. The first is that the accounting component earnings before extraordinary items (EBX) were not introduced to the Norwegian accounting principles before 1999, and by the available components, it is not achievable to deduct equivalent earnings to establish comparable

figures before 1999. The second limitation occurs due to the average growth calculated over a five-year period prior to the test year. This results in a testing period that extends over the year 2004-2018. Firms that cannot present EBX figures within those five years before the test years are excluded. In accordance with Lev and Gu (2016), the firms that exceed ±15% growth within the five years are also excluded. This is to avoid volatile firms which might return unrealistic results.

**Model**

This test calculates the average growth rate of the firms' ordinary earnings before extraordinary items over a five-year period. The estimated results for each test year are calculated based on this growth rate applied to last year's earnings.

The following mathematical model is applied:

*Equation 6*

$$\widehat{EBX}_i = \frac{\omega_{i-5} + \omega_{i-4} + \omega_{i-3} + \omega_{i-2} + \omega_{i-1}}{5} EBX_{i-1}$$

The *EBX* variable represents earnings before extraordinary items, while ω represents the percentage growth of EBX between two years. Each year is denoted as *i*. The deviation is thereafter calculated from the percentage difference between estimated and actual reported earnings for the test year. The following mathematical model is applied:

*Equation 7*

$$error_i = \frac{EBX_i - \widehat{EBX}_i}{EBX_i}$$

The average deviation for each year is further calculated and compared over the stated test period from 2004-2018.

*Earnings before extraordinary items (EBX)*

This variable is applied instead of net income as the earning estimator because it excludes expenses that are not directly affiliated with the firm's operation. This test is sensitive to infrequent occurrences and might apply incomparable costs to one of the test years. Preferring EBX instead of net income is a countermeasure to these issues.

### 3.5.3 Previewing Experiment 3: Balance Sheet Hypothesis

In consistent with Choi et al. (2000), the third test intends to address the second aspect of answering the thesis by assessing the intangible assets that are already captured in the financial reports. According to Norwegian accounting law, intangible assets might be included in the accounting figures, either by capitalization or expenses. To be able to file intangible assets in the financial reports, some prerequisites must be met in accordance with the current regulations as mentioned in NRS 19. Experiments 1 and 2 focus on the relevance of the accounting figures, while this experiment focuses on the relevance of the intangible assets in those figures.

**Test Portfolio**

Three different test portfolios are created in accordance with Choi et al. (2000). The first one is called the *Experimental Portfolio* and consists of firms with considerable intangible assets. The second portfolio is the *Control Portfolio* and consists of firms with no intangible assets. The third portfolio is called *Adjusted Portfolio* and is the same firms as in the experimental portfolio, but the intangible assets are subtracted. The adjusted portfolio aims to enable comparable figures between the firms with intangible and the control portfolio. The selection of the experimental observation must satisfy two critical criteria. The ratio of intangible assets to the total asset is greater than 10% and are calculated by the *proportion of reported intangible assets to total assets* (PIA). Second, this ratio should be consistent over a three-year period in advance and should not fluctuate by more than 50%. The cross-sectional analysis is performed by a *Paired T-test,* which pre requires a matching protocol. Matching the experimental and control firms are performed by two criteria. The observation is from the same year, and they belong to the same one-digit NACE code. A visualised model explaining the matching procedure can be found in the appendix [3].

**Method**

Two different tests are performed, one for all public listed firms on OSE where the market value is available, and a second where all enterprises with available accounting figures are included. The hypothesis test for the first dataset is called *MV Balance Sheet Hypothesis* (MVBSH), and the second is called *All Balance Sheet Hypothesis* (ABSH). The MVBSH test consists of five measurements: [1] PIA, the *proportion of reported intangible assets to total assets*; [2] TA, *total assets*; [3] BE, the *book value of common equity*; [4] EBX, *earnings before extraordinary items*; [5] BM, *book-to-market value ratio*. The ABSH test

consequently consists of four measurements, where BM naturally cannot be calculated because of the absence of comparable market valuation.

*PIA variable*

The proportion of reported intangible assets to total assets determines how many intangible assets a firm possesses. A number above 50 percent indicates that the firm has more intangible assets than tangible. Choi et al. (2000) describe intangible intensive firms as those with a PIA ratio above 15 percent and are utilized to subset the experimental portfolio. This study calculates this variable to measure how much of the reported intangible are present in Norwegian firms additionally to create the experimental portfolio. A 10 percent limit is set instead of the 15 percent used in Choi et al. to include more firms. This is a consequence of an originated data sample with fewer observations. The following formula calculates PIA:

*Equation 8*

$$PIA = \frac{Intangible\ assets}{Total\ assets}.$$

*Total Assets (TA) variable*

As the name implies, this variable measure all the assets, both intangible and tangible, that the firm possess. Assets are in general, items that represent an economical value for the firms, which can be expended to be operational beneficial for the firm. In this study, the total asset is included in determining the overall size of the tested company, which helps in comparing the different result from this experiment.

*Book-to-market value ratio (BM) variable*

The BM variable refers to the ratio between the booked value (equity) and the firm's market valuation. A smaller value indicates that the market value weighs the equity less importance and, consequently, suggests other factors than the reported equity that affect the market valuation. The following formula calculates the BM variable:

*Equation 9*

$$BM = \frac{Book\ value\ of\ common\ equity}{Market\ Value}.$$

*Both the BE and EBX variable are covered respectively in experiment 1 and 2.*

Further, the Wilcoxon signed-rank test is then performed based on five alternative hypotheses:

H2(MVBSH):

*The book-to-market value ratio of the adjusted portfolio is less than the book-to-market value ratio of the control portfolio.*

H3(MVBSH):

*The book-to-market value ratio of the experimental portfolio is less than the book-to-market value ratio of the control portfolio.*

H4(ABSH):

*The book value of common equity is lower of the adjusted portfolio than the book value of common equity in the control portfolio.*

H5(ABSH):

*The book value of common equity is lower of the experimental portfolio than the book value of common equity in the control portfolio.*

H6(ABSH):

*Earnings before extraordinary items of the experimental portfolio are lower than earnings before extraordinary items in the control portfolio.*

The alternative hypothesis of 2 and 3 follow the same logic as Choi et al. (2000), the BM ratios of the adjusted and control portfolio will be equal if the market asses zero value to intangible assets. If the BM ratio of the experimental portfolio is equal to the control portfolio, the market asses the same value to intangible and tangible assets. If the market valuates intangible positively, the BM ratio of both experimental and adjusted would be lower than the control portfolio. The alternative hypothesis (4-6) asses the same signed ranked test on the two key measurements used in experiment 1. If the BE measurement is lower for the adjusted portfolio than for the control portfolio, it would mean that intangible intensive firms are in a higher degree securing their investments through intangible assets. Consequently, would it mean that intangible assets are less important if the experimental portfolio returns lower values for the BE measurement than of the control portfolio. The last test assesses the overall performance of each individual firm, where a lower value of the

EBX measurement in the experimental portfolio than the control portfolio would indicate worse performance.

In addition to the signed ranked test, a regression analysis is performed similarly as in experiment 1 by predicting the market value. However, this test is performed in accordance with Choi et al. (2000), where the independent variables are: *book value of total assets minus property, plant, and equipment and intangible assets* (ABPI), *the book value of property, plant, and equipment* (PPE), *book value of intangible assets* (IA), *book value of the sum of liabilities plus book value of the preferred stock* (LIAB). Since figures for the preferred stock were not available, the LIAB variable is in this model based on the firm total liabilities. In contrast to the initial OLS regression analysis performed in experiment 1, this test is centred around balance sheet items to determine whether intangible assets are positively associated with the market valuation. This regression model intends to determine whether a change in the proposed predictor variables causes a change in the firm's market valuation. This is decided by assessing the following alternative hypothesis:

H7: *There is a relation between the intangible asset variable regarding the market valuation.*

**Model**

Specification of the signed ranked test:

*Equation 10*

$$W = \sum_{i=1}^{N_r} [sgn(x_{2,i} - x_{1,i}) \cdot R_i]$$

Specification of the regression model:

*Equation 11*

$$MV_{it} = \beta_0 + \beta_1 ABPI_{it} + \beta_2 PPE_{it} + \beta_3 IA_{it} + \beta_4 LIAB_{it} + e_t$$

### 3.5.4 Previewing Experiment 4: Inherent Goodwill Hypothesis

The former experiments are conducted based on the reported accounting figures. As previously stated, intangible assets consist of both identifiable and unidentifiable assets. While the identifiable intangible assets are included in the reported accounting, the

unidentifiable are withheld from the general reporting criteria. The intention of this experiment is the attempt of disclosing the internally generated goodwill and displaying them accordingly. This is done in preference to incorporating them in the explanatory framework of the three previous experiments. The rationality for this commitment is based on the mathematical process of calculating the corresponding values, and because of causation may not be combined with the dependent variables already included.

**Test Portfolio**

The test portfolio of this experiment consists of all listed companies on the OSE in the period between 2010-2018. Contrary to the former experiment, the exclusion of non-profit maximizing firms is not performed as performance variables are not included in this experiment. Additionally, the test result solely displays the calculated values for each firm, which further eliminates any issues regarding firms in a non-competitive environment. Firms with no adjacent market valuation are excluded from the sample data, and all values included in the calculation are adjusted by inflation.

**Model**

There are four variables in this experiment: *market value* (*MV*), *tangible assets* (*TA*), *identifiable intangible assets* (*IIA*) and *acquired goodwill* (*AG*). The notations "*i"* and "*t"* represents firm and year, respectively. Combined, they are measuring *inherent goodwill* (*IG)* and forms the following mathematical expression:

*Equation 12*

$$IG_t = \sum_{i \in I} MV_{it} - TA_{it} - IIA_{it} - AG_{it} \qquad ,\forall t \in T$$

**Method**

There are two primary outcomes in this analysis, hence establishing the following alternative hypothesis:

H8: *Inherent goodwill is increasing for the listed companies.*

The intention of assessing this hypothesis is to acquire information regarding intangible assets' development and characteristics. Provided that the previous experiments are in line with acknowledged articles they are based on, it is expected that the development of inherent goodwill is increasing. According to Haskel and Westlake (2018), the cumulative

deterioration of the relevance of accounting figures is explained by an ever more indulgent application of intangible assets. As the current reporting practices are limited in only displaying identifiable intangible assets, an increasing trend of inherent goodwill will support their claim.

The proposed calculation model [eq. 12] is applied to the test portfolio, returning a summary of the inherent goodwill for each individual company. Further assessment of the test result comprises a categorically ranking of the individual firm into three subcategories based on the quantile of the median values. These three categories represent the top 25 percent, median, and the bottom 25 percent based on the amount of inherent goodwill in 2018. This measure can help us display any clear trend in the industry, governmental interference, or company size. For instance, more prominent firms would consequently retain a more apparent influence on the results than other firms. This occurrence is more frequent when operating with a data sample that consists of a dominant proportion of firms in a specific industry and its accommodated industry effects. The exact measurements were included by M. Bloom (2009), where specific industries deemed irrelevant were removed from the data sample. Potential bias deriving from larger firms having significantly more impression on the total trend than smaller operators are treated by presenting each individual firms' development of inherent goodwill. Consequently, each firm will be categorized as either overvalued or undervalued. An overvalued firm is defined by demonstrating positive inherent goodwill. Likewise, undervalued firms demonstrate inherent negative goodwill. As opposed to the more traditional procedure by comparing the booked valuation of the firms against the market value, these experiments attempt to disclose the difference by denoting it as unidentifiable intangible assets. Both procedures follow the same concept, whereas this approach subtracts the identifiable intangible assets from the equation.

This far, all four experiments have been introduced, which leads to the end of this chapter. The following section will contain the results and corresponding interpretations from all experiments.

# 4. Analysis

In this chapter, results from all four experiments will be displayed and interpreted.
The structure will follow the same logic as the one in the methodology section, where each experiment, 1-4, will be reviewed separately in chronological order. Additionally, an accumulation of all experiments where their combined results are being discussed will be established at the end of this chapter.

### 4.1.1 Experiment 1: Market Value Hypothesis

The intention of performing the first experiment is to examine whether the accounting information is relevant for describing each firm's market valuation of each respective firm. This is in accordance with the multiple regression analysis performed by Lev and Gu (2016). As they denote, the analysis returned an adjusted R squared value which declined from 80-90% in the 1950s to around 50% in 2013. The accustomed regression analysis performed in this experiment covers the time perspective from 2010-2018. Therefore, the results from the analysis are expected to return an adjusted R squared value similar to the 2013 result of Lev and Gu. The following OLS regression model [eq. 5] is fitted for the available data over the 2010-2018 time period:

$$MV_{it} = \beta_0 + \beta_{1t} NI_{it} + \beta_{2t} BE_{it} + \beta_{3t} NHS_{it} + e_{it}$$

To simplify the illustration of the test results, this chapter will focus on the test year of 2013. This is conducted to compare Lev and Gu's results better and illustrate some of the results. A complete test result for all tested years is included in the appendix [4].

**OLS Regression Analysis – 2013**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 6519000 | 2496000 | 2.6120 | 0.0110 |
| NI | 22.8000 | 2.9160 | 7.8160 | 0.0000 |
| BE | -1.5790 | 0.3990 | -3.9550 | 0.0000 |
| NHS | 0.0210 | 0.0080 | 2.6560 | 0.0100 |
| Adjusted $R^2$ | 0.89 | | | |
| F-value | 206.307 | | | |
| N | 77 | | | |

| Studentized Breusch-Pagan Test | |
|---|---|
| p-value | 0.009 |

*Table 1 Result of regression analysis for experiment 1*

The Breusch-Pagan test is performed to check whether the regression is heteroscedastic or homoscedastic. The p-value is $< 0.05$, and the evidence is sufficient to determine that heteroscedasticity is present, and further adjustment to the model is required. As previously mentioned, a countermeasure to heteroscedasticity is either to adjust the response variable by a logarithmic scale or by applying a weighted OLS regression model. Both approaches were applied to the model, however, none of them returned a satisfactory result. Adjusting the response variables with a logarithmic scale admittedly improved the model regarding the heteroscedastic issue and consequently aggravated the predictor variables' significance. Alternatively, the weighted regression model was fitted with a weighted variable based on the standard deviation of each observation. This method did not affect the heteroscedasticity, however, the significance level of each predictor variable worsens. The bias that occurs as a consequence of the heteroskedasticity is denoted as an indication that the fitted model might not retain the explanatory power it claims by the $R^2$ values. Heteroscedasticity is observed only in the regression model of 2013 and 2018. Although the results return p-values for the coefficients variable that shows significance, this is not representative of the results from the other test years. Further, a correlation matrix is calculated to determine whether the included predictor variables contain multicollinearity between each other.

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.93 | 0.90 | 0.62 |
| NI | | 1.00 | 0.98 | 0.65 |
| BE | | | 1.00 | 0.74 |
| NHS | | | | 1.00 |

*Table 2 Correlation matrix*

Multicollinearity is an expected consequence, as the independent variables represent economic figures that in their nature do correlate with each other. An alternative OLS regression model is adapted to adjust for multicollinearity by including an interaction term between equity (BE) and net income (NI), which from the correlation matrix possess the highest correlation. The following regression model is then fitted:

*Equation 13*

$$MV_{it} = \beta_0 + \beta_{1t} NI_{it} + \beta_{2t} BE_{it} + \beta_{3t} NHS_{it} + \beta_{4t}(NI_{it} \times BE_{it}) + e_{it}$$

This model yields the following regression results:

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 4126000 | 2367000 | 1.7430 | 0.0860 |
| NI | 27.3200 | 2.9140 | 9.3760 | 0.0000 |
| BE | -1.3700 | 0.3690 | -3.7070 | 0.0000 |
| NHS | 0.0250 | 0.0070 | 3.3650 | 0.0010 |
| NI×BE | 0.0000 | 0.0000 | -3.8810 | 0.0000 |
| Adjusted $R^2$ | 0.908 | | | |
| F-value | 188.3 | | | |
| N | 77 | | | |
| Studentized Breusch-Pagan Test | | | | |
| p-value | 0.002 | | | |

*Table 3: Results from OLS Regression analysis for the year 2013*

As mentioned, both regression test yields coefficients that are significant. The adjusted R squared values are from the original regression equal to 0.89 and rise to 0.91 in the alternative model. As James et al. (2013) denote, the $R^2$ always raises when additional variables are included in the model. Therefore, the additional interaction term does not extensively increase the explanatory power of the model. Compared to the test results of Lev and Gu for 2013, the differences are however notable. While their test result returned an

adjusted $R^2$ value of 50 percent, this study's test results are similar to those they noticed in the 1950s. Gather over multiple years, the development of the $R^2$ value behaves as follows:

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| Adjusted $R^2$ | 0.89 | 0.88 | 0.87 | 0.89 | 0.81 | 0.79 | 0.83 | 0.78 | 0.86 |
| F-value | 152.40 | 147.52 | 147.94 | 206.31 | 113.60 | 216.63 | 182.03 | 148.21 | 270.25 |
| N | 57 | 62 | 70 | 77 | 80 | 117 | 112 | 123 | 133 |

*Table 4: Development of adjusted R2*

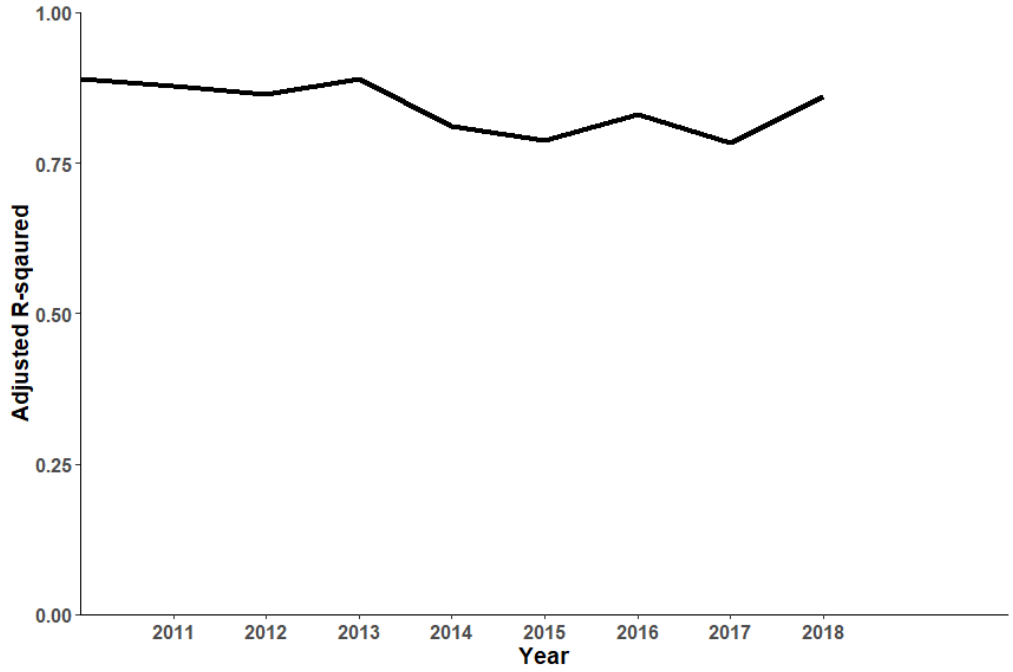


*Figure 1: Graphical visualisation of the development of adjusted $R^2$*

The results from experiment 1 can with certainty assert that the financial figures included in the test are, compared to the results of Lev and Gu, more significant in describing the market value. However, the significance of the predictor variable is fluctuating between the test years, and consequently, only 2013, 2015, and 2018 return satisfactory test results regarding the acceptance of the alternative hypothesis (H1). Therefore, the initial alternative hypothesis (H1) is partly rejected. However, the regression model returns a substantially higher explanatory power of the predictor variables compared to Lev and Gu. While the null hypothesis is accepted, the proximity of the significance for some variables indicates that minor adjustment to either the model or test portfolio might contradict these test results. The sign of heteroskedasticity in some regression models indicates the contrary, but this phenomenon is not commonly observed.

**Revised analysis**

While examining the correlation matrix for each individual test year, a phenomenon where the correlation between income and equity fluctuates unexpectedly attracts attention. Referring to the correlation matrix in the appendix [6], one can observe that the correlation deteriorates for the period of 2014-2016 and indicates a negative value for the years 2015 and 2016. For the remaining test years, the correlation returns values of between 95-98%. For the 2014-2016 period these numbers are 54%, -63%, -32% respectively. As the Norwegian economy is heavily centred around the petroleum industry, and the authors of this paper are aware of the oil-price recession between 2014-2016, the causation of the observed deterioration seems apparent. Another test is performed on the same regression model with an adjusted test portfolio. All firms associated with the *mining and quarrying industry*, referring to the SIC 2007 classification, including petroleum activities, are excluded from the tested data sample. A comprehensive review of the adjusted regression result is found in the appendix [5]. The following figure represents a graphical compilation of the returned adjusted R2 values:

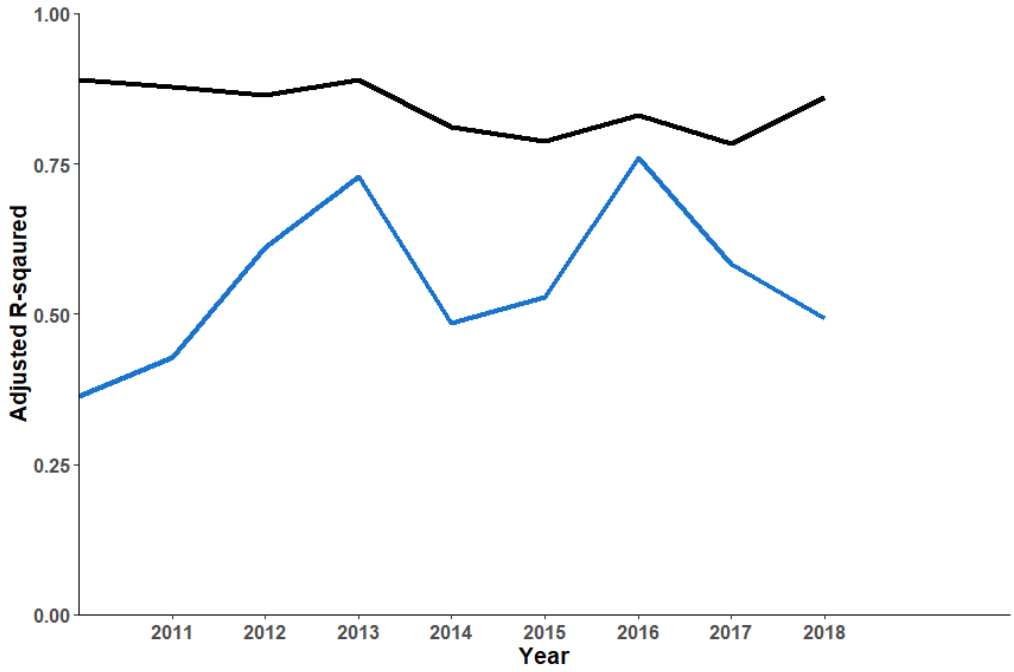


*Figure 2: Graphical visualisation of both the initial development of adjusted R2 in black and for the revised development in blue*

By removing the petroleum sector, the regression model becomes less fit, and consequently that the predictor variable explains a smaller amount of the market value. The results from the adjusted experiment 1 are also more in line with the findings of Lev and Gu. The Breusch-Pagan tests indicate that heteroskedasticity is present in the regression results. This

is a further indication that the current model consists of an increasing bias. Adjusting the data sample by removing the petroleum industry eliminates the precipitation of the correlation and overall returns a more stable value. In contrast to the initial test result, the returned adjusted $R^2$ values indicate that the accounting indicators included in the regression model have a decreased explanatory power regarding the market valuation.

### 4.1.2 Experiment 2: Earnings Estimate Hypothesis

The purpose of experiment 2 is to adopt similar estimations as Lev and Gu (2016) to predict future earnings. The model is based on sampling the average growth of income the last five year prior to the test year and adding it to this year to predict next year's earnings. The previous experiment found that the accounting information explained 85-90% of the market valuation. However, those figures are heavily dependent on the interpretation of the investors and how they emphasize this information. This test intends to be dependent on the accounting data itself solely, and to which degree the information retrieved there are reliable to predict future earnings. In other words, how relevant are the accounting figures in terms of the newness of the information it reveals. The following equation [eq. 6] is calculated for each test year from 1999-2018:

$$\widehat{EBX_i} = \frac{\omega_{i-5} + \omega_{i-4} + \omega_{i-3} + \omega_{i-2} + \omega_{i-1}}{5} EBX_{i-1}$$

The prediction error is found by calculating the following equation [eq. 7]:

$$error_i = \frac{EBX_i - \widehat{EBX_i}}{EBX_i}$$

EBX is represented by earnings before extraordinary items and is retrieved from the SNF data set. The growth of earnings between two years is denoted as ω. The prediction error formula is then performed for each test year, which displays the following result:

**Prediction error**

| 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| 0.3767 | 0.3808 | 0.3648 | 0.4751 | 0.4842 | 0.3781 | 0.3622 |
| **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** |
| 0.4014 | 0.4139 | 0.3885 | 0.4673 | 0.3859 | 0.3700 | 0.3948 |

*Table 5: Development of the prediction error*

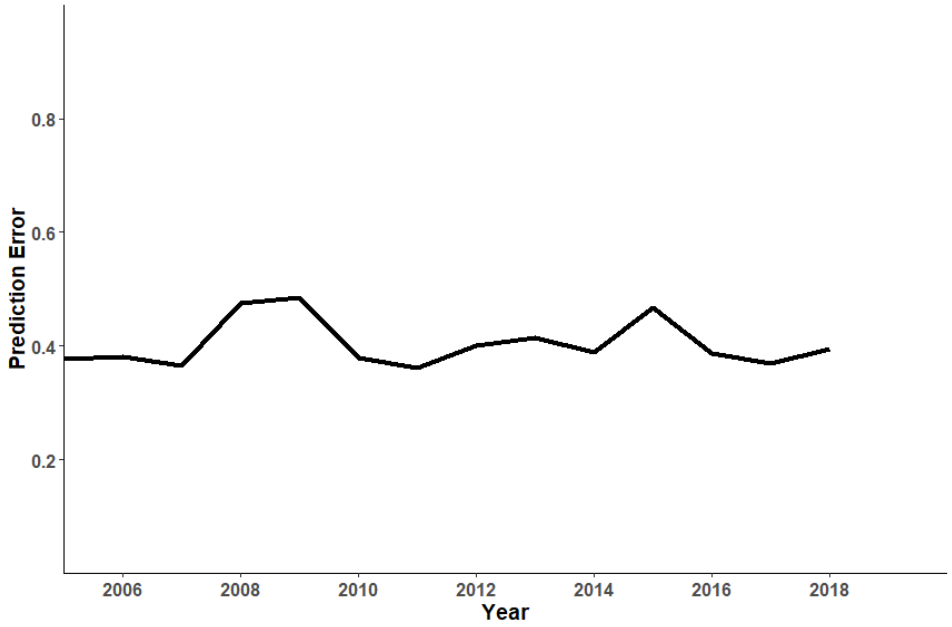


*Figure 3: Graphical visualisation of the development of the prediction error*

The results indicate that utilizing previous earnings in predicting future earnings returns relatively poor predictions. Lev and Gu's test indicated an increasing growth of the prediction error equal to 20 percent in the late 2000s. The prediction in this study demonstrates a relatively steady prediction error of around 40 percent. One of the differences between these two studies is that Lev and Gu are testing for a smaller sample of firms similar to the one in experiment 1. Additionally, they calculate a 10-year average of the prediction error to eliminate fluctuation further. However, this analysis indicates that the prediction power of the accounting information is relatively poor observed over a longer time perspective. As stated, this experiment intends to determine whether the information found in the accounting figures is sufficient to explain its earnings and thus disclose its performance. These results indicate that firms' earnings fluctuate in a deviating manner which is not captured by the available accounting figures. Contrary to the results in experiment 1, which demonstrated a higher prediction power of the accounting figures, the results from experiment 2 are not affected by the investors' subjective interpretation and perception of these figures. These results indicate that either is the market valuation of a firm is wrong, or the trends in the market are insufficiently explained by the accountings.

### 4.1.3 Experiment 3: Balance Sheet Hypothesis

While the two previous experiments attempt to determine the explanatory power of accounting information, this experiment focuses on intangible assets in that regard. Three tests are accustomed to determining whether the reported intangible assets in the accounts compromise sufficient information. In accordance with Choi et al. (2000), a Balance Sheet Hypothesis is applied, where a Paired t-test is utilized on two different test groups consisting of two test portfolios. This establishes the basis for the two first tests, where the first one is compromising firms with included market value and the second of all enterprises with available accounting information.

**MV balance sheet hypothesis**

Three test portfolios are created based on public listed firms on the OSE and associated market values.

*Experimental Portfolio*

The portfolio is selected according to the established requirements, where each included firms accommodate at least 10 percent or more intangible assets regarding total assets. Each firm are also required to maintain this ratio for at least three years prior to the test year and the ratio should not fluctuate by more than 50 percent. The number of observations in the experimental portfolio change over time, and the following numbers are retrieved:

| Observation in the Experimental Portfolio | | | | | | |
|---|---|---|---|---|---|---|
| **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** |
| 6 | 7 | 7 | 7 | 8 | 11 | 12 |

*Table 6: Number of observations in the experimental portfolio*

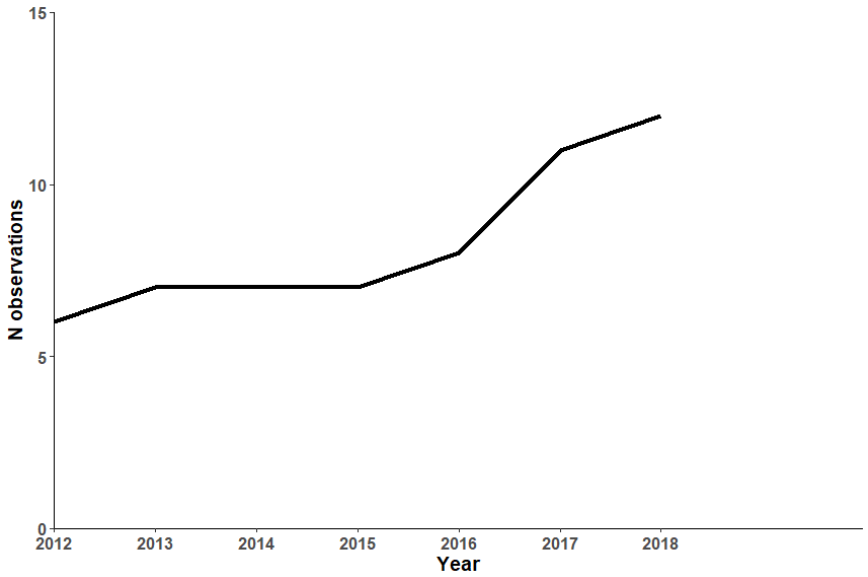


*Figure 4: Graphical visualisation of the development of observation in the experimental portfolio*

*Adjusted Portfolio*

The adjusted portfolio consists of the same firms as in the experimental portfolio, but the intangible assets are removed from the embedded figures.

*Control Portfolio*

A comparable objective is established by developing the control portfolio, which contains all the firms with zero reported intangible assets. The fluctuation in the numbers of observations in the control portfolio is as follows:

Observation in the Control Portfolio

| 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| 20 | 21 | 24 | 30 | 37 | 45 | 53 |

*Table 7: Number of observations in the control portfolio*

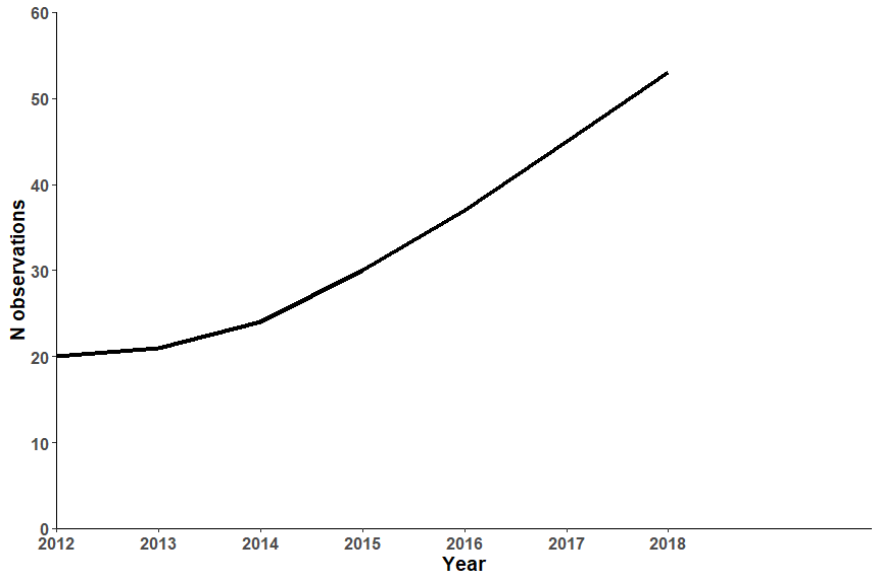


*Figure 5: Development of observations in the control portfolio*

The initial results show that the number of firms with more than 10 percent intangibles is relatively low but increasing. From 2012 to 2018, the number rose from 6 to 12 observations. For the control portfolio, the same can be said for firms with no intangible assets, which from 2012-2018 had an increasing number of 20 to 53. In 2012 there were in total 159 firms listed on OSE with coherent accounting information. The remaining 133 firms not included in the portfolios possess more than zero intangible assets but have less than 10 percent. This is respectively a considerable part of the firms included in this test. However, no adequate procedure to incorporate them in this experiment is implemented. The ratio between experimental and control observation is displayed as follows:

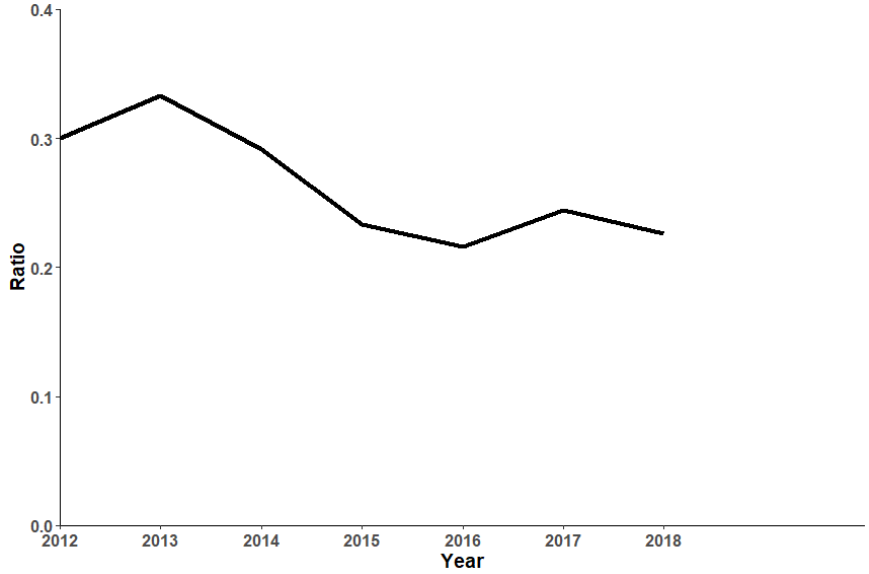


*Figure 6: Ratio between observation in the experimental and control portfolio*

This trend line demonstrates that the number of firms with no intangible assets increases faster than those with intangibles.

A pair-wise matching process is performed, where each firm is matched by their respective industry code and year. The results consist of multiple groups where each group consists of firms from the experimental/adjusted and the control portfolio where the industry code and year are the same. For each group, a mean value for each test variable is calculated for each portfolio. This returns two mean values for each group and then compiled to one data matrix called test objective. The Shapiro-Wilk test is performed for each test objective to determine whether it follows a normal distribution of its data, consequently determining the type of paired t-test to perform. This experiment is adapted to either perform the so-called Student's t-test (when normal distributed), or the Wilcoxon Signed Ranked t-test (non-normality). The Shapiro-Wilk test returned no p-values lower than 5 percent, and all test objectives were tested by the Wilcoxon t-test. This returned the following result:

| | Mean Value | | | p-value from Paired t-Test | |
|---|---|---|---|---|---|
| **Variables** | **Experimental** | **Adjusted** | **Control** | **Experimental-Control** | **Adjusted-Control** |
| PIA | 0.2502 | | | | |
| TA | 7895531 | 5392463 | 10387941 | 0.8117 | 0.7593 |
| BE | 2148870 | -354199 | 2646501 | 0.5854 | 0.0000 |
| EBX | 467090 | 467090 | 102869 | 0.0460 | 0.0460 |
| BM | 0.2743 | 0.1300 | 0.6103 | 0.1678 | 0.0290 |

*Table 8: Results of the Wilcoxon Signed Ranked t-test of MVBSH*

Interpreting these results should be performed with caution. The mean value represented to the left is the mean value of all values. The paired t-test determines the differences between the mean value of each test objective. Therefore, the p-value from the t-test might show no significant difference, while the interpretation of the mean values might indicate the contrary. In accordance with the alternative hypothesis H2 (MVBSH):

> *The book-to-market value ratio of the adjusted portfolio is less than the book-to-market value ratio of the control portfolio.*

The results indicate that the book-to-market ratio is significantly lower for the adjusted portfolio than the control portfolio, where the paired t-test returns a p-value of 0.0290. The p-value is less than 5 percent, and therefore the null hypothesis is rejected. Consistent with Choi et al. (2000), this result further indicates that the market positively values intangible assets. The second alternative hypothesis, H3 (MVBSH):

*The book-to-market value ratio of the experimental portfolio is less than the book-to-market value ratio of the control portfolio.*

The interpretation of the mean value indicates that the BM-ratio is lower for the experimental portfolio, however, the paired t-test returns a p-value of 0.1678, which is more than 5 percent, and the null hypothesis is accepted. One cannot determine whether the market values intangible assets more than tangibles.

**All Balance Sheet Hypotheses**

The second test performed utilizes all the available data from SNF on the same analysis performed for the first test. While adapting the model on the public listed firms on OSE is adequate when assessing the market value, the observation numbers are relatively low. Introducing more firms from the accounting data is beneficial in that matter and, consequently, prevents the model from considering the market evaluation that the BM figures reveal. The same matching procedure is implemented, and the following results are retrieved:

| | Mean Value | | | p-value from Paired t-Test | |
|---|---|---|---|---|---|
| Variables | Experimental | Adjusted | Control | Experimental-Control | Adjusted-Control |
| PIA | 0.3870 | | | | |
| TA | 154255 | 96718 | 115578 | 0.0000 | 0.0019 |
| BE | 46919 | -10618 | 23280 | 0.0003 | 0.0000 |
| EBX | 4686 | 4686 | 1580 | 0.0012 | 0.0012 |

*Table 9: Results from the Wilcoxon Signed Paired t-test of ABSH*

Three additional alternative hypotheses are included when assessing the second balance sheet test H4 (ABSH):

*The book value of common equity is lower of the adjusted portfolio than the book value of common equity in the control portfolio.*

and H5 (ABSH):

*The book value of common equity is lower of the experimental portfolio than the book value of common equity in the control portfolio.*

The mean value of booked equity indicates that the adjusted portfolio features less equity than the control portfolio, and the differences are significant according to the t-test. The p-value is less than 5 percent, and therefore the null hypothesis can be rejected. Seen in the

context of alternative hypothesis H5, results show a significant difference between the experimental and the adjusted portfolio. However, the booked equity of the experimental portfolio is considerably higher than that of the control portfolio. While remembering that booked equity is total assets minus liabilities, the results indicate that total assets are higher for the experimental portfolio. Examining the ratio between equity and total assets,

$$BE\ ratio = \frac{Booked\ Equity}{Total\ Assets},$$

which shows that the BE ratio for the experimental group is 0.3042 and for the control portfolio is 0.2142. This demonstrates that the initial results from the analysis indicate that firms with a considerable amount of intangible assets tend to control more of their assets.

The last hypothesis from this experiment is examining the earnings, which is supported by the following alternative hypothesis H6 (ABSH):

> *Earnings before extraordinary items of the experimental portfolio are lower than earnings before extraordinary items in the control portfolio.*

The results show that the experimental portfolio tends to possess higher reported earnings than the control portfolios. The difference is significant, as proved by the paired t-test. The alternative hypothesis is therefore rejected.

**OLS Regression Analysis of Balance Sheet Items**

The regression analysis performed in experiment 1 focuses on reviling the relevance of the accounting information regarding the market value. The regression analysis performed in this experiment attempts to determine the explanatory power of balance sheet items regarding the market value. Recalling the regression model:

$$MV_{it} = \beta_0 + \beta_1 ABPI_{it} + \beta_2 PPE_{it} + \beta_3 IA_{it} + \beta_4 LIAB_{it} + e_t$$

The predictor variables in this model are retrieved from the balance sheet of each firm. Book value of total assets minus property, plant and equipment, and intangible (ABPI) consist of assets that are more associated with the operational component of the firm. The following variable, Book value of property, plant, and equipment (PPE) consists of assets supporting or facilitating the value creation activities of the firm. The All Balance Sheet hypothesis results indicate that both total assets and equity tend to be higher for firms with a considerable amount of intangible assets. Both ABPI and PPE attempt to determine whether assets

positively affect the market value and, consequently, how the market asses these figures. The book value of intangible assets (IA) variable consists of the reported intangible assets in the firm. Determining the relevance of the intangible predictor variable is a central element of this analysis because previously found MV balance sheet analysis results indicate that the market values intangible assets. Therefore, the results from the regression analysis would either further support or dispute these findings. The last variable, the book value of the sum of liabilities plus the book value of the preferred stock (LIAB), explains the relevance of the firm's liability regarding its market value. It is expected that liabilities would negatively affect the market value as more debt consequently introduces more risk towards the investment object. This regression model is then performed on all publicly available firms for each year in the period 2010-2018. For the sake of demonstration, every other year is displayed in the table below, however, a more comprehensive table for each year can be found in the appendix [11].

| | **2010** | | **2012** | | **2014** | | **2016** | | **2018** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Estimate | Pr(>\|t\|) | Estimate | Pr(>\|t\|) | Estimate | Pr(>\|t\|) | Estimate | Pr(>\|t\|) | Estimate | Pr(>\|t\|) |
| (Intercept) | 636400 | 0.6720 | 1178000 | 0.3810 | 1626000 | 0.0280 | 2364000 | 0.0200 | 1935000 | 0.0720 |
| ABPI | 1.8920 | 0.0000 | 1.4950 | 0.0000 | 1.0540 | 0.0000 | 1.7290 | 0.0000 | 2.0410 | 0.0000 |
| PPE | 16.6400 | 0.0000 | 15.3900 | 0.0000 | 18.0900 | 0.0000 | 13.1400 | 0.0000 | 13.9200 | 0.0000 |
| IA | 7.2610 | 0.0670 | 5.6380 | 0.1490 | 0.3280 | 0.7820 | -11.2500 | 0.0000 | -12.2600 | 0.0000 |
| LAIB | -2.0000 | 0.0000 | -1.5900 | 0.0000 | -1.0970 | 0.0000 | -1.7810 | 0.0000 | -2.1290 | 0.0000 |
| Adjusted $R^2$ | 0.962 | | 0.960 | | 0.984 | | 0.949 | | 0.945 | |
| F-value | 455.399 | | 491.957 | | 1469.738 | | 556.346 | | 634.388 | |
| N | 72 | | 83 | | 99 | | 120 | | 148 | |

*Table 10: Results from OLS regression analysis for experiment 3*

There are three interesting findings from this regression analysis. The first one is that both ABPI and PPE indicate a significant explanatory power to the market value for the whole period. The facilitating assets retain a more substantial explanatory power over the operational assets, which can be observed by the estimation values between ABPI and PPE. The second finding is, as expected, that liabilities negatively impact the market value, which can be observed by the estimation values for LIAB. The last and arguably the most important and more peculiar results are that for the 2010-2015 period, intangible assets seemingly have a declining explanatory power over the market value, and the results are not significant. The explanatory power is strongly negative for the 2016-2018 period and consequently returns a more substantial result. The declining and subsequently negative estimator values are contradicting the initial test result regarding the alternative hypothesis H2 and H3. The

associated alternative hypothesis (H7) is rejected for the years 2010-2015 and partly accepted for 2016-2018.

**Revised Regression Analysis**

Consistent with the revised analysis of experiment 1, these test results indicate that the observed recession in the petroleum sector retains an associated explanatory factor for experiment 3. This is based on the fluctuating values of the estimator values for the intangible coefficient variable, which implies an intensification from 2014 onwards. By implementing the same exclusion on the sample data as in experiment 1, the regression model returns a much more stable estimation value, as shown in the following figure:

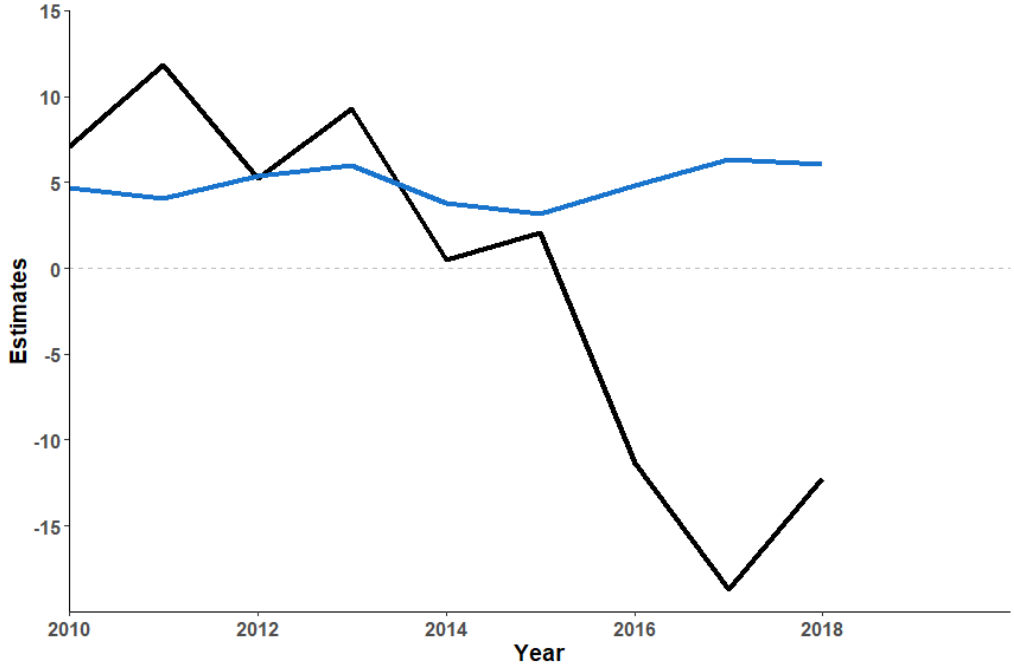


*Figure 7: Visualisation of the development of the estimation value for the coefficient of the intangible asset predictor variable. The black line is from the initial test, while the blue is from the revised test.*

The more stable and now positive estimation values for the intangible coefficient return a more consistent result with Choi et al. (2000), which indicated the same. Other estimator values are also more in line with the reviewed literature as the ratio between ABPI and PPE is closer. While the results do not indicate a better fit of the regression model, it does better support the findings in the MV balance sheet hypothesis, which stated that the market positively values intangible assets. A more comprehensive review of the revised regression results can be found in the appendix [12].

### 4.1.4 Experiment 4: Inherent Goodwill Hypothesis

This experiment intended to measure the amount and development of inherent goodwill. The firms were sorted into three different segments: top 25%, median companies, and bottom 25% based on their respective amounts of this value. They will all be separately reviewed before they are accumulated. The results will be discussed with a focus on causation and implication.

#### *Graphic representation*

**Top 25%**

The top 25% contains 39 companies that hold the highest inherent goodwill per 2018. The development is steady, and the inherent goodwill has doubled throughout 2010-2018, going from approximately 8 000 000 000 to 16 000 000 000.

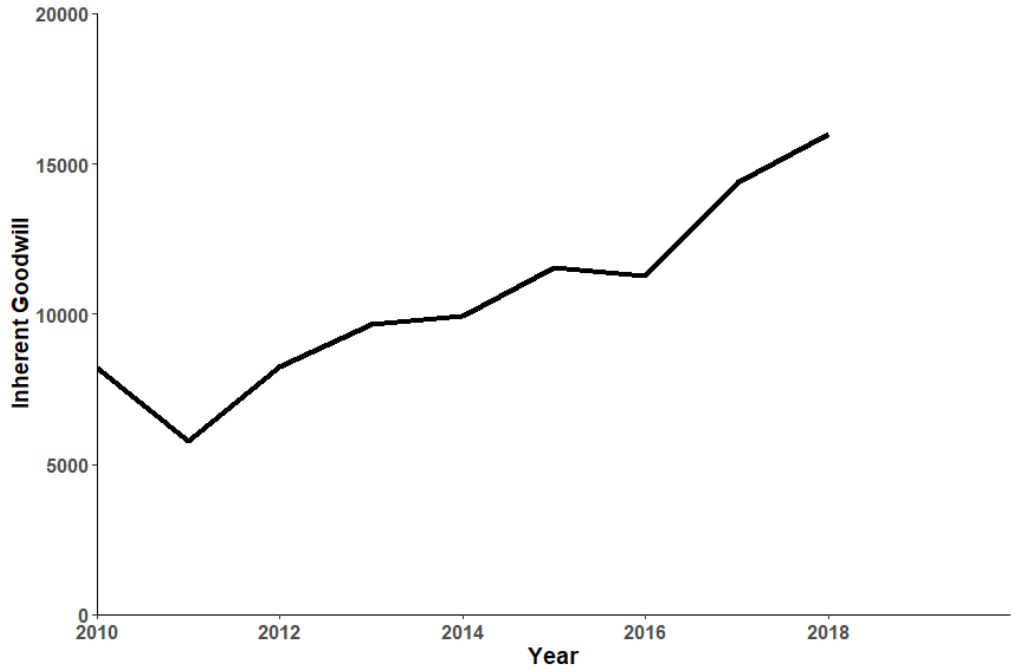


*Figure 8: Top 25% (Experiment 4), figures of IG are shown in per million*

Among the 39 different companies, the most dominant industry is the seafood industry, having six listed companies in the top 25% category. Furthermore, biotech, shipping, renewable energy hold the second, third and fourth highest presence in this group. Table 11 displays the top five companies in our data set:

| Top five companies | Inherent goodwill per 2018 | Industry |
|---|---|---|
| *Telenor* | 196 685 627 | Telecommunications |
| *Yara International* | 75 392 867 | Agricultural Bio |
| *Mowi* | 52 109 654 | Seafood |
| *SalMar* | 36 132 904 | Seafood |
| *Lerøy seafood group* | 33 760 356 | Seafood |

*Table 11 Top 25% (Experiment 4):*

**Median companies**

The median companies represented a sample of the 56 businesses that illustrate the median of this analysis. It also displays an increasing trend of inherent goodwill, but with diminishing returns from 2013-2018, stabilizing the graph. The 56 companies are a mix of different industries equally distributed on the stock exchange. The industry with the highest presence is offshore service-related companies providing drilling and other maritime operations. Renewable energy, medicine, property, and biotech are also well represented in this group of companies.

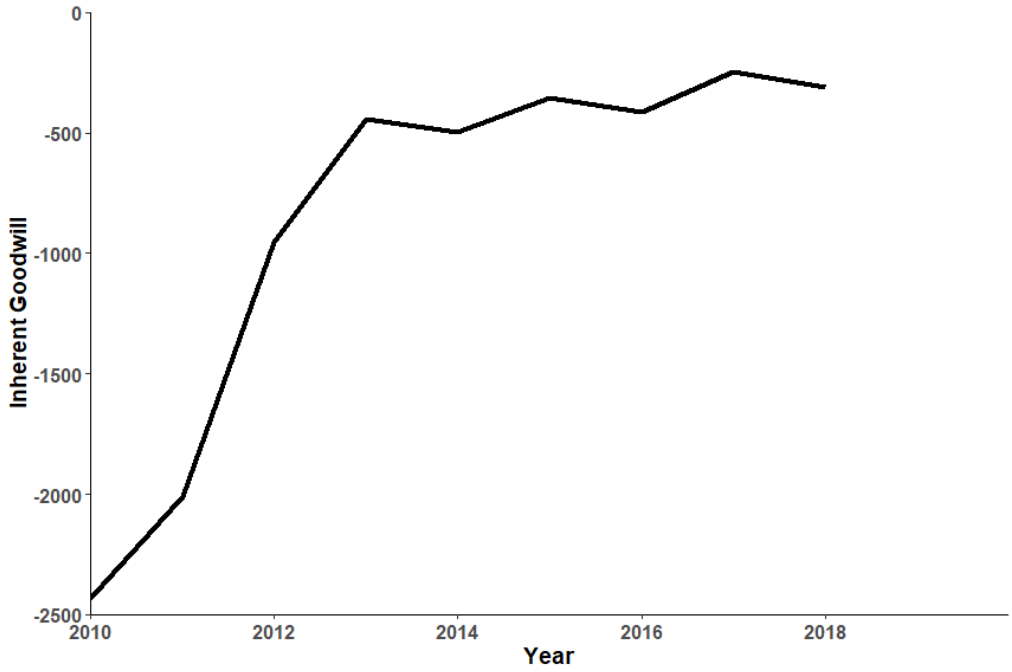


*Figure 9: Median (Experiment 4), figures of IG is shown in per million*

**Bottom 25%**

The bottom 25% represents the 44 companies having the lowest recorded amount of inherent goodwill per 2018. These companies are heavily undervalued and do not seem to follow the same trend as the other groups. The graph is declining, reaching a bottom around 2014-2015 before it recovers back to its original value just below -60 000 000 000.

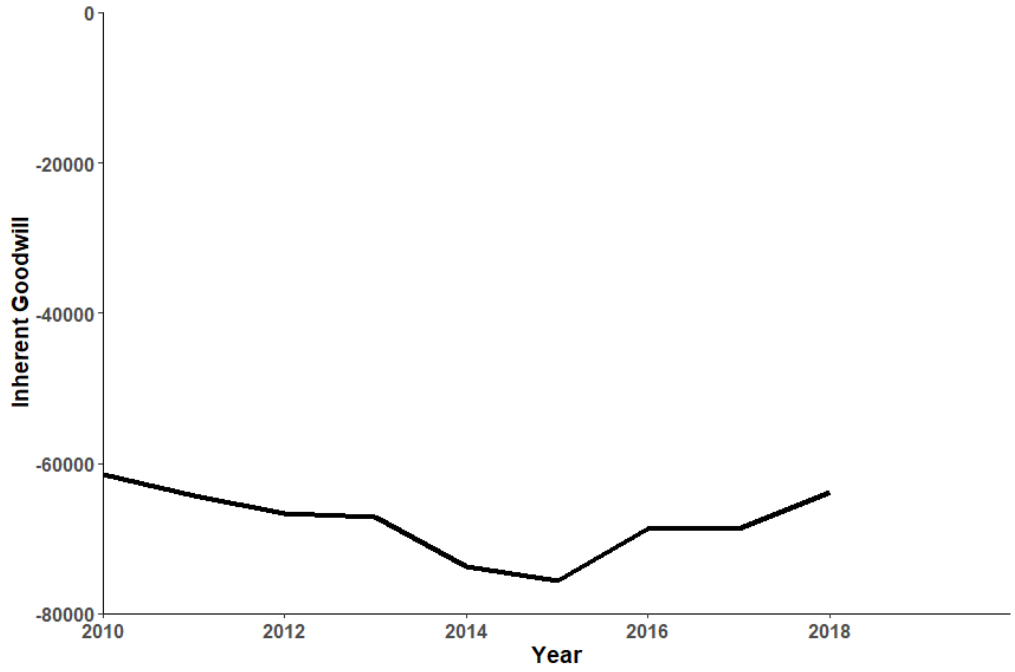


*Figure 10: Bottom 25% (Experiment 4), figures of IG is shown in per million*

There is a very distinct type of firm in this group; banks and large Oil & Gas operators. In fact, 16 of 20 bottom firms as well as 61,3% of the firms in this category, are banks. Equinor, AkerBP, DOF, and Norwegian Air Shuttle are also large companies located alongside the banks down in this group. Table 12 displays which companies hold the lowest inherent goodwill per 2018.

| Bottom five companies | Inherent goodwill per 2018 | Industry |
|---|---|---|
| *DNB* | -1 576 604 902 | Banking |
| *Equinor* | -162 160 858 | Oil & Gas |
| *SpareBank 1 SR-Bank* | -145 828 416 | Banking |
| *SpareBank 1 SMN* | -135 413 073 | Banking |
| *SpareBank 1 Østlandet* | -104 076 089 | Banking |

*Table 12: bottom five companies (Experiment 4)*

**All firms – Total trend**

There are 173 firms on Oslo Stock Exchange per 2018. If we disregard the numbers on the vertical axis, the graph holds similar characteristics to figure 10, which displays the bottom 25%. However, some key differences: Apart from 2011 and 2014, which respectively, are the minor and major downfalls of the recorded period, the market seems to be gradually increasing. The development is adequate in the interval 2011-2013 but more significant in the interval of 2014-2018.

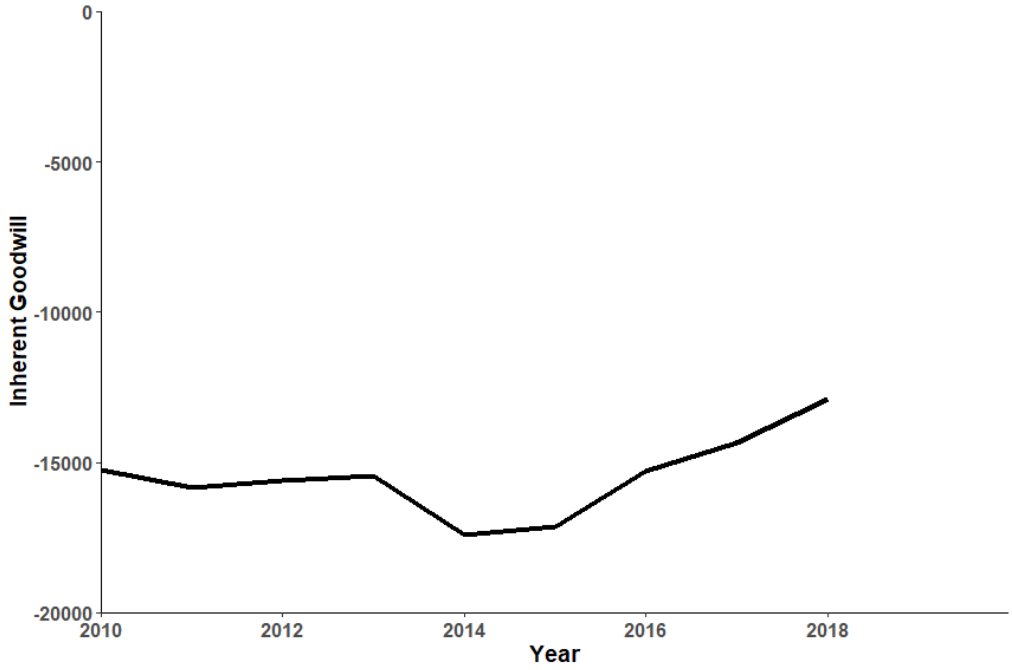


*Figure 11: Trend of all firms (Experiment 4), figures of IG is shown in per million*

The examination of independent development of valuation yields results that indicate a growing proportion of the listed companies being overvalued. According to table 13, the percentage of overvalued businesses has grown from 27,03% in 2010 to 52,02% in 2018, which is almost a doubling in percentage points. "t-1 relative development" is added to reflect yearly development and displays how many companies that went from being undervalued in the previous year to being overvalued the recorded year, meaning that companies that were newly listed a year are not caught up in this statistic.

| **Valuation** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** |
|---|---|---|---|---|---|---|---|---|---|
| *Overvalued* | 40 | 34 | 40 | 50 | 54 | 65 | 76 | 88 | 90 |
| *Undervalued* | 108 | 121 | 119 | 111 | 107 | 99 | 95 | 85 | 83 |
| *Total firms* | 148 | 155 | 159 | 161 | 161 | 164 | 171 | 173 | 173 |
| *T-1 relative development* | - | -13 | 2 | 8 | 4 | 8 | 4 | 10 | 2 |
| *% Overvalued* | **27,03** | **21,93** | **25,15** | **31,05** | **33,54** | **39,63** | **44,44** | **50,86** | **52,02** |
| *% Undervalued* | 72,97 | 78,07 | 74,85 | 68,95 | 66,46 | 60,37 | 55,66 | 49,14 | 47,98 |

*Table 13: Overvaluation analysis*

The results show that the Oslo Stock Exchange is heavily undervalued in terms of inherent goodwill. This is opposed to the Australian market in M. Bloom (2009) study, where it was concluded that roughly 50% of all values were positive inherent goodwill, signifying an overall overvaluation according to our terms. The question is why the OSE is undervalued, which might be answered through the market's industry dependency. Relatively speaking, the OSE is a small stock market, meaning that large operators will significantly impact accumulative key figures for the market. In our data set, 27 out of 174 variables are banks, which will affect the total trend, but especially the lower 25% bracket where 27 out of 44 variables are banks. In fact, the removal of the bank industry in this experiment returns positive inherent goodwill – overvaluation of the OSE.

So why do banks display such low rates of inherent goodwill, both in total numbers and in development? First, addressing the initial part of the question, banks in Norway are usually stable, influenced by the government, and hence will not make any unpredicted jumps in the stock market, making it sensible to hold lower values, in our case negative, of inherent goodwill. The latter part of the question can be explained by the fact that an increase in inherent goodwill is often associated with an enhanced operating income for the company, which is rare for banks once numbers are corrected for inflation. In a partly regulated

country such as Norway, the banks are more dependent on macroeconomic factors rather than private ones, and hence low values of inherent goodwill and no trend in terms of development are inevitable.

**Cracks in the trend**

In our analysis, we have one minor and one major downfall: 2011 and 2014, respectively. It is essential to address these periods to understand better how figure 8-11 is being influenced by external factors that, if left unexplored, can conceal or weaken our argument.

For 2011, there is nothing significant going on in the Norwegian economy, but one could argue the potential of a ripple effect from the global financial crisis of 2008. Expanding the database would be an action of interest to see how the values fluctuate from 2007-2010. Alas, the accessibility of this data would deem to be a problem. It is also necessary to consider that when operating with a relatively small data set of nine years, the possibility of a year being slightly worse than the others is expected due to natural variations in the economy.

In 2014 Norway had one of its biggest oil crises of our time. The utilization of fracking in the US and OPEC response with increasing its production were arguably the two main factors leading to a fall in the oil price (Fredriksen & Johansen, 2015). A straightforward implication this has for our research is a significant crack in the year 2014, which is then slowly recovering through the next couple of years. This affects our data and parts of the interpretation when the question of whether the low values of 2014 lead to an enhanced trend the following years, arises. Rephrased, if we look at 2014 t0 as and 2018 as t1, the oil crisis and hence the low values of 2014, could potentially make the trend measured from 2014-2018 more significant since it is not only capturing the development of inherent goodwill, but also the recovery of the national economy.

Additionally, a secondary product of our research is a clear representation of how dependent the Norwegian stock market is on the global oil & gas market and, thereby, how sensitive it is for changes in the oil price. Whenever the oil price drops, negative synergy effects trigger, not only hitting the actual oil & gas companies but their suppliers, their service companies, the exploration- and drilling experts, and other maritime operators. This explains figure 9, the median companies, where most of these suppliers and oil service companies are. They all have a distinct development of inherent goodwill until 2014 where it stagnates.

Furthermore, when an economy has so many businesses that directly or indirectly deal with oil & gas as their field of operation, the banks are also affected due to macroeconomic oscillations. This is displayed in the bottom 25%, figure 10, where we have no significant development but a significant downfall in 2014. The only segment that looks unaffected is the top 25% which returns a linear development with no cracks.

**Conclusion of analysis**

Despite the two challenges of having industry-biased characteristics and investigating a stock market that heavily depends on a specific industry within a period where that exact industry faces a significant crisis, the analysis returns some interesting results in terms of development. If we disregard the banking industry from the analysis, which arguably is the least relevant industry for our research and focuses on the companies that are not believed to show heavy dependency on the oil & gas market, there is a clear trend in terms of development, suggesting a 100% increase in some sectors. The growing proportion of overvalued firms, from 27,03% to 52,02% over the period examined, should also be considered a significant development. The fact that the median companies displayed a rapid increase in inherent goodwill and stagnated in 2014 rather than dropping is an interesting element to consider, implying a generally growing amount of inherent goodwill in this sector.

We claim these results to be sufficient to reject the null hypothesis and henceforth assume an ongoing trend regarding the development of inherent goodwill on the Oslo Stock Exchange. The complete interpretation of the results will be discussed further in another subchapter.

### 4.1.5 Accumulation of experiments

In summary, experiment 1 yields an explanatory rate of 80-90%, experiment 2 returns a prediction error of 40%, experiment 3 shows that the market positively values stated intangible assets, and experiment 4 argues for a gradually increasing amount of inherent goodwill. The results slightly differ from them of previous research (Lev & Gu, 2016; Choi et al., 2000), but when revising some of the research, more explicitly removing the operators related to the *mining & quarry industry*, which was also done in the study of Bloom (2009), experiment 1 yields similar results to those of Lev & Gu. Experiment 3 also now displays a

more stable and accurate estimation model for the valuation of intangible assets. These results and their implications will be thoroughly discussed in the following chapter.

# 5. Discussion

The trend described in Lev and Gu (2016) is proven to apply to the Norwegian market, however, as a subject to adjustments. The essence of the test results indicates that the ruling accounting practices do not capture a growing proportion of a companies' values. Simultaneously, is there evidence that the market positively values the reported intangible assets while the unreported intangibles are apparent to increase. This chapter will consist of a comprehensive discussion of the obtained experimental results as reviewed in the previous chapter.

## 5.1 Comparison of reviewed literature results

The first section of the discussion will compare the retrieved results from this study to the ones that the methodology is based on. This purposefully considers the results in the conceptual context and emphasises that the included experiments are conducted accordingly with current literature and theory.

### 5.1.1 Comparing the application of accounting

Lev and Gu (2016) performed a similar regression analysis as performed in experiment 1. Their results indicated that the explanatory power of the tested predictor variables consists of a declining trend which was clarified by their 2013 results that displayed an adjusted squared $R^2$ value of around 50%. Additionally, this was supported by their experiments of the prediction power of earnings which stated an increasing trend in the prediction error. For the equivalent 2013 period, the prediction error raised to around 20%. These two experiments that Lev and Gu performed, among others, indicate that the information in the accounting data is insufficient to capture the truth of the firm's performance. They conclude that this is a severe issue that can negatively affect different levels of the market. The results from this study are not directly consistent with Lev and Gu. From experiment 1, we found that the explanatory power of the tested predictor variables is around 85-90%. Simultaneously, the results from experiment 2 indicate that the prediction power of the accounting information is more insufficient than the result from Lev and Gu, with a prediction error of around 40%. To understand this difference, it is necessary to assess to which degree these experiments are comparable to Lev and Gu. While they are more or less the same experiments model-wise,

the data samples are different. Lev and Gu examine all public listed firms in the United States, which is somewhat different compared to the same selection of the Norwegian market. A more significant proportion of the public listed firms on the Oslo Stock Exchange OSE are categorized in the manufacturing (C) or the transport industry (H).

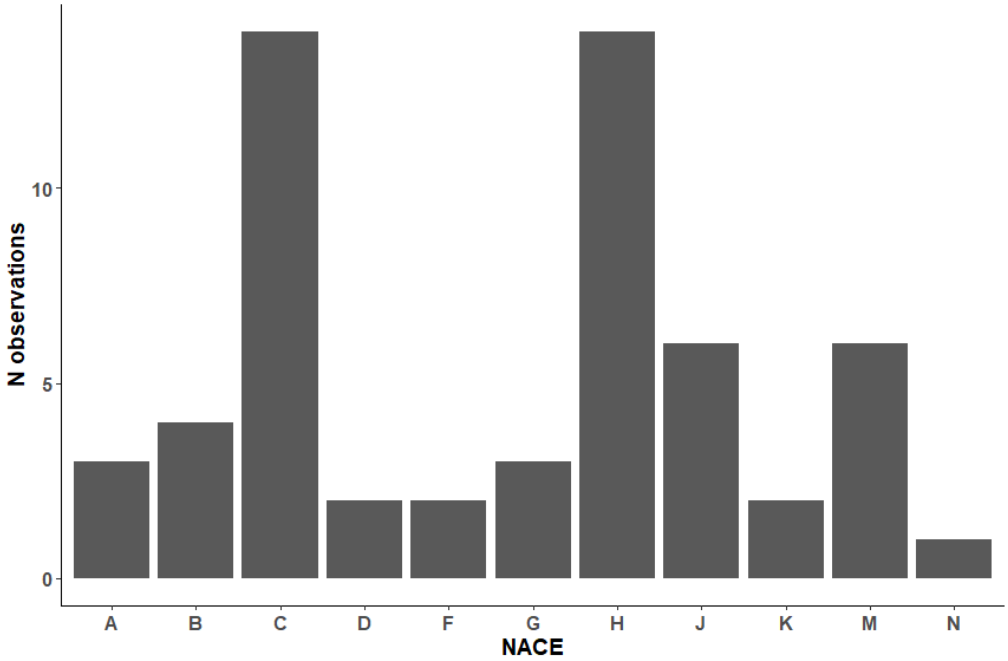


*Figure 12: Proportion of number of firms in each industry*

In addition, the petroleum industry (B) is an essential factor in assessing the Norwegian stock market and the economy as a whole. Lev and Gu do not provide a revision of the firms included in their tests. However, a summary of the S&P500 indicates some differences opposed to the OSE (Fidelity, 2021). Sectors affiliated with manufacturing and transportation on the S&P500 index retrieve a considerable share of the market capitalization, but the overall market capitalization for all industries is more equally distributed. A significant difference is that the information technology sector retains a significantly higher market capitalization in the US compared to the other sectors. This phenomenon is not observed in the sample data from OSE, which this study depends on. As described in the theoretical background on intangible assets, IT firms tend to retain more intangible assets, which might explain the differences between the results from the regression of Lev and Gu and this study.

Another explanation might be constituted in the differences between accounting standards, where the GAAP standard for US-based companies is applicable. Firms listed on OSE are required to file their accounting after the IFRS standard. A comprehensive review of the

general differences between GAAP and IFRS is outside the scope of this thesis. However, and as denoted by the Securities and Exchange Commission (2011, p. 9), the significant differences between the two standards are that GAAP is ruled-based while IFRS is principle-based. This means that the IFRS guideline is less detailed in practice, which consequently leaves more room for interpretation than GAAP. There might be a logical conclusion in that a more rigid accounting standard prevents crucial information regarding the performance of the firms to be captured. Especially concerning intangibles where the firm's interpretation is essential in assessing the valuation.

The discussed differences might explain some of the differences between the results from the regression analysis. However, the tests do not reveal any information regarding the cause. Lev and Gu's experiment of the prediction power of earnings is mostly in line with their findings in the regression analysis. While the regression analysis revealed a declining trend of the explanatory power, the prediction error test returned an increasing trend. This study's regression analysis results show a stable trend line of the adjusted squared $R^2$ value and the prediction error. However, the adjusted $R^2$ value indicates a strong explanatory power of the prediction variables regarding the market value, while the prediction error returned a poor result. These two results contradict, where the regression analysis indicates that minimal amounts of information are not captured by the accounting, whereas experiment 2 suggests that a considerable share of the information is missing. The differences between Lev and Gu's experiments of the prediction error are based on the same data sample as in their regression analysis. Experiment 2 is based on a considerably larger data sample, including all firms in Norway with available accounting data. This was done to further eliminate issues with fluctuation that were impossible to eliminate by the same procedure as Lev and Gu. They complied their prediction error over a 10-year average interval, where they had disposable data back to the 1950s. This study was limited to testing the years between 2005 and 2018. The data sample from OSE consisted, after excluding irrelevant industries, between 2010-2018 of 57-133 observations. The differences between the figures were too perceptible to return a reliable answer on so few observations. There is no clear indication that the selection of a more extensive sample data including more firms is the primary justification for these differences. However, it might be among the numerous explanatory factors.

### 5.1.2 Comparison of intangible assets

Alternating the focus towards the third experiment of this study and comparing the test result of Choi et al. (2000). Their test concludes that the differences between the booked-to-market value ratio (BE) are significantly lower between the adjusted and control portfolios and, consequently, indicates that the market positively values intangible assets. The results from experiment 3 in this study are in consistent with the stated results from Choi. The fitted OLS regression analysis implemented to support the initial tests further returns unexpected differences between this study and Choi et al.. In contrast, their regression analysis supports the results of their initial balance sheet hypothesis, while the results from this study are not consistent. The regression results of Choi et al. show that both ABPI and PPE return estimates that equal to each other with a slightly stronger emphasis on PPE. Both results are significant. The same result from this study indicates a stronger emphasis on PPE, which returns considerably higher estimates over all test years. This might be explained by that Choi et al. primarily focuses on US-based firms in the manufacturing industry, whereas this study includes all firms. However, as denoted earlier, the dynamic in the Norwegian stock market is heavily biased towards the manufacturing industry as well. The significant differences are regardless observed for the intangible assets predictor variable (IA). Choi et al.'s test results indicate that intangibles are of slightly less importance than ABPI regarding the explanatory power, and the test results are significant. The results for IA from this study involve more complexity than those of Choi’s et al.. For the test years between 2010 and 2015, the regression results' estimation values are consistent with Choi et al., however, not significant. Test results from 2016-2018 indicate a considerable change, where the test estimates are substantial negative and unexpectedly indicates significance. Further review of this phenomenon is conducted later in this chapter.

Summarizing the comparison between the experiments in this study that are developed based on the reviewed literature and the test results from said literature indicates that the experiments conducted in this study are, to some degree in consistent. The differences might be explained by the different utilization of available data samples.

## 5.2 Legitimacy of accounting

The proposed research question for this study considers the legitimacy of accounting regarding the characteristic of the development of intangible assets. This section will cover the discussion of whether the current accounting practices are sufficient to capture the performance of the firm and its actual value. The results from experiments 1 and 2 are applied to assess the relevance of the accounting information further.

### 5.2.1 The relation between the market the accountings

As denoted by the results from experiment 1, the Norwegian stock market tends to assess a relatively high value in the information retrieved from the accounting. The adjusted $R^2$ value retains a relatively stable quantity over the 2010-2018 test period of around 80-90 percent. The considerably higher relevance compared to the results of Lev and Gu are somewhat unexpected. This leads to the argument that financial reports from the listed companies on OSE accommodate most of the information that investors utilize to determine the market value. As denoted by Lev and Gu, the market valuation might be an insufficient measure to assess the relevance of the accounting information due to the individual bias that the investors are affected by. The results from experiment 2 contradict the initial findings by allocating a lower prediction power for the selected accounting figure. The prediction error retains a stable quantity of 40 percent for the test period. These results should be reviewed in consistent with each other. As experiment 2 utilizes the earnings before extraordinary items (EBX) figures, a prediction error of 40% would mean that the past average growth generally produces an inaccurate estimate by plus minus 40 percent, the previous year’s EBX figure. This consequently reveals that the firm’s performance is not able to be determined on the basis of the accounting information. Thus, some of the information regarding the performance are not captured by the accounts. The market valuation contradicts this and states that the accounting information is sufficient in determining the firm's performance. An investor is interested in predicting the firm's future performance to determine the object's investment potential. However, as numerous investors and analysts estimate future performance, the stock price tends to align with the actual performance prior to the release of the financial reports. This phenomenon might explain why the past performance's prediction power is lower than the market valuation and consequently allocate a higher relevance of the accounting information regarding the market value.

### 5.2.2 Confidence in the experiments

While the test results might imply that the legitimization of the accounting is not as aggravated as the literature states, the uncertainty of the results should be evaluated. The OLS regression analysis in experiment 1 returns overall confidence in the retrieved results. For the years 2013 and 2018, the Breusch-Pagan test indicates that heteroscedasticity is observable in the regression analysis. Adequate countermeasure fails to remove this impediment, and we choose to denote this increase in bias as further evidence that the initial result might not be as confident as first implied. The explanatory power of the included predictor variables for net income (NI) is generally significant over the test period, with a few exceptions. Both in 2015 and 2016, the net income returned estimation value for the coefficient relatively close to zero, supplemented with a more substantial estimate for equity. All other years, the estimation value tends to be considerably higher than the one for equity. Additionally, the fluctuation in the estimation value for the income coefficient is severe through the test period. This indicates that other factors influence the firm's market value, although this is not observed through the adjusted $R^2$ value.

Furthermore, the equity (BE) predictor variable fluctuates consistently with the income variable, which aligns with the relatively high correlation between the two as observed from the correlation matrix (Appendix [6]). An interesting observation is that for the years 2014-2016, the correlation between the two deteriorated and indicated negative values for 2015 and 2016. As denoted in the previous discussion, the Norwegian economy is heavily centred around its petroleum sector. We know that for the period between 2014-2016, a recession in the oil price had a considerable effect on the industry. Adjusting the data sample by removing the petroleum industry eliminates the precipitation of the correlation and overall returns a more stable value. The estimation values for both income and equity still fluctuate; however, the low values and consequently insignificant result for income in 2015 and 2016 are eliminated. The more remarkable observation is that the adjusted R2 value has deteriorated from 80-90 percent to fluctuate between 40 and 75 percent. By removing the petroleum sector, the regression model becomes less fit. Consequently, the predictor variable explains less of the market value. An explanation of this might derive from the indication that the market value of firms associated with the petroleum sector is heavily dependent on the included variables for income and equity. These results further reinforce the sign that accounting information is less relevant in explaining the market value. The results from

experiment 1 are also more in line with the findings of Lev and Gu, in addition, to be more consistent with the findings found in the prediction error from experiment 2. The data sample for experiment 2 consists of a broader selection of firms, which might explain why the initial results indicated inferior relevance of the accounting information. Nevertheless, the petroleum sector should not be depreciated from the experiments conducted in this study as it still is a central part of the economy. However, it does indicate that future issues regarding the legitimacy of accounting might arise as the market capitalization of the petroleum cascades.

Another concern challenging this legitimacy of accounting is the growing proportion of values not caught up in the accounts, namely the inherent goodwill. Experiments 4 yields a development in this area vary depending on the industry and size of the company, but the key takeaway is that it affects all businesses to some extent. The same conclusion can be drawn from the OLS regression analysis from experiment 3, where the coefficients of the four variables ABPI, PPE, IA, and LAIB stay relatively stable in terms of variation whilst the intercept value is increasing over the years. This implies that the variables' impact ratios on the market value remain the same, but the impact of values we cannot identify increases – accounts are less capable of reflecting relevance. In simple, graphical terms: Each year, the graph will have the same shape, but its starting value will be higher. This can threaten the legitimacy of accounting since the accounts are no longer able to provide complete and necessary information to its reader in order for them to make good predictions on stock prices. The gradually increasing values that are not caught up in financial reports is also challenging this legitimacy. Lev and Gu also argue for this based on their findings and hence named their book the end of accounting. Although our experiments do not return identical results like theirs, due to investigation of different markets, the consensus of the research points in the same direction, claiming deficiency in the current reporting system and thereby attacking the legitimacy of accounting.

## 5.3 Relevance of intangible assets

This section assesses the characteristics of intangible assets and their implications regarding the initial results discussed in the prior section. Recalling the research question for this thesis, the proposed idea is that intangible assets affect the robustness of the accounts.

Experiment 3 and 4 were applied to assess this proposition and are the foundation for further discussion.

### 5.3.1 Valuation of intangible assets

The first test of experiment 3, MV Balance Sheet Hypothesis, attempts to determine whether the market assesses value to the reported intangible assets and whether its effect is positive or negative. As the results indicate, the market positively considers the reported intangible assets proved with a higher market value. This is consistent with previous findings of Choi et al. (2000) and Jennings et al. (1996). However, as denoted previously in the section for comparison between the two results, the regression analysis in the third test indicates the contrary. The results from the regression analysis imply that for the year 2010-2015, the reported intangible assets positively affect the market value, with fluctuating levels of significance levels. In 2016-2018 the effect changed dramatically to a negative estimation value for the coefficient, referring to table 10. A possible explanation might be observed through the substantial relative fluctuation in the estimation value for intangible assets. As shown in the analysis and discussed in the prior section of this chapter, the recession in the petroleum sector between 2014-2016 indicates apparent causation in the returned test results. Adjusting the data sample for the regression analysis by removing the petroleum sector returns a more stable estimation value for the intangible coefficient. Furthermore, it also retains a positive value for all years and is also significant for 2013-2018. The estimation values for both ABPI and PPE maintain a closer ratio similar to Choi's results. These results reinforce the confidence that the severe fluctuation in the estimation value for the intangible assets was dominated by the petroleum industry, and by removing them consequently reinforced the regression analysis. This also means that the regression analysis does support the initial test results from the MV Balance Sheet Hypothesis, which stated that the market does positively value intangible assets. However, the actual causation of the adjusted test result concerning the petroleum sector has not been further investigated.

### 5.3.2 Assessment of the confidence in the test results

The All Balance Sheet Hypothesis was developed to determine firms' performance with a substantial ratio of intangible versus those without. As indicated by the test result of the portfolio comparison, the intangible intensive firms tend to have higher earnings compared to the others. The test result might, however, be interpreted with some caution. Since the

amortization cost of intangibles is not assessed as it owns post in the accounts but is incorporated into all assets' total amortisation costs, the comparison between the two portfolios (adjusted-control) is affected by some inaccuracy. The adjusted portfolio should have removed the intangibles' amortization cost to compare the two portfolios. Consequently, the EBX variable should be higher. The explanation for why the earnings tend to be higher for the intangible intensive firms are two-sided. One reason might be that intangible intensive firms retain a supreme performance compared to those without intangible assets. Another explanation might be that the intangible intensive firms are more sizeable. The results from the hypothesis ABSH 5 and 6 support this. From table [9], both total assets and equity are significantly more extensive for the intangible intensive firms. We believe the source of the explanation for this phenomenon partially is constituted in the Norwegian accounting standard (NRS19). The total intangible assets consist of four items: deferred tax asset, research and design, patents, and goodwill. The assessment of these items is treated in the accounts with emphasis on the firm's own ability to assess its value. A more prominent firm most likely possesses more resources to evaluate these items accurately.

Additionally, more prominent firms might be more favourable to inherent higher values for both R&D and patents. This is a consequence of said resources that fund the R&D department and make it possible to acquire highly valuable patents. Bigger firms might also be more likely to acquire other companies, which generates more goodwill. Experiment 4 indicates that more prominent firms also have the potential to possess more inherent goodwill, which further intensifies the reported goodwill. However, this only applies when that firm is already considered overvalued. If undervalued, big firms tend to drop considerably, and therefore, we can find large companies at the bottom of the inherent goodwill rankings, such as DNB and Equinor. Nevertheless, we believe that the current accounting standard, principles, and laws are favourable to more prominent firms. The small and medium-sized firms most likely possess a higher intangible to total assets ratio than what is observed in the experiments performed in this study. These experiments, unfortunately, do not reveal any evidence nor information for this claim. This entails unreliable prediction when reported intangible assets are included, like for the regression analysis performed in experiment 3. As stated, the test results support the claim that the market positively values intangible assets. However, these results are solely based on the reported intangible assets and not the actual value of the intangible assets. In line with the

perspective discussed that more prominent firms are more able to report intangible assets, the regression analysis might return a higher estimation value for the intangible coefficient.

Consequently, allocate higher confidence in the estimation value because more valuable firms tend to possess more intangibles and vice versa for the small-medium sized firms. This reasoning creates the basis for our statement that, although the experiments performed in this thesis indicate that intangible assets are positively connected with the capitalization of the market value and performance, it cannot be a definite answer regarding the overall research question. The applicable accounting practice inadequately covers the characteristics of the intangible assets, hence produce an inaccurate measurement of the value possessed by each firm.

### 5.3.3 Characteristics of development

Recalling the initial research question of whether the characteristics of the development regarding intangible assets challenge the legitimacy of accounting, the included experiments indicate that the current accounting practices contain an abbreviated legitimacy in explaining individual firms' performance. Supplementing experiments prove to some extent that the characteristic development of intangible assets might express the causation. While the three initial experiments yield helpful information, experiment 4 directly addresses the increasing problem in terms of the characteristics of the development of intangibles. The results indicate that firms are achieving a higher value creation than reported in the accounts. The results fluctuate between just a few percent increase to nearly a doubling in the calculated value. In the introduction to this thesis, the historical time perspective was considered in assessing this development. As stated in the reviewed literature, intangible assets are present in most aspects of the firm. We express that a substantial part of this development should be denoted to the changing dynamic regarding extensively digital development within the firm. As data utilization is becoming increasingly essential in the competitive framework, the necessity of an accurate approach to display the associated values increases. Take the implementation of artificial intelligence as an example. NRS19 states explicitly that expenses associated with the "*development regarding introduction or essential upgrading of software or standard systems or processes…*" (Regnskapsstiftelsen, 2012) are prohibited. Cost of acquisition should be expensed with associated operating assets (e.g. tangible assets like computers or servers). Therefore, the enterprise is restricted to only display the actual increase in earnings, if that is the case, but not the associated assets nor the potential that

derives from such innovative activities. This is a statement to the limiting ability of current accounting practices only to display the result of the firm's strategic adjustment, which gives little to no accurate assessment of the value creation. As stated by Lev and Gu and further discussed earlier in this chapter, the market valuation of a firm tends to align itself to the true value before the disclosure of the accounting figures. Referring to Christensen's (2018) three levels of ambition regarding digital development: digitizing, digitalization, and digital transformation. As Christensen states, most firms' ambition still relates to the first level. This means that more firms will increase their digital development in the future and thus increase associated intangible assets.

## 5.4 Proposed changes

Deriving from the results, it is evident that the current reporting practices regarding intangible assets are insufficient. Today's accounting standards, including GAAP, IFRS, and NRS, contemplate intangible assets the same way as tangible assets. The same principles are applied through stricter limitations for which intangible to include. The purpose with audited accounting principles regarding intangible assets is not necessarily to include more of them in the accounts. The objective should be to capture more value-creating assets that disclose the firm's ability to achieve superior performance in a competitive framework. Further in this section, a review of the possible direction for assessing intangible assets is discussed.

### 5.4.1 Stick to status quo

Before exploring the different alternative alterations, it is essential to highlight the most likely scenario in the short term: Sticking to the status quo. Due to humans' inertia in catalyzing changes, this scenario can be reasonable, and it is essential to discuss its challenges. To summarize from the earlier discussion, the main threats to this scenario are inaccurate information to the authorities to assess the state of the economy, less reliable information to the investors, and deficient overview for the firm itself when developing and deploying its strategy. These threats are not as severe for the Oslo Stock Exchange due to its relatively small size and industrial dependency, but as denoted in a newspaper article (Bjeregaard, 2020), the number and capitalization of tech firms are rising. Keeping the current accounting practices might, in the short term, not affect the assessment of the issues

discussed earlier. However, the indication from the experiments' results states that it is an increasing issue.

### 5.4.2 Allowing to display unidentifiable intangible assets

Applying less restrictive accounting practices to enable each company to display unidentifiable assets on their balance sheets would result in a more open and stable environment for investors. Theoretically, incentives, hence exchanging inside information, could decrease due to this action, making the stock exchanges fairer for investors and traders. However, and as stated in this study, assessing the valuation of intangible assets is a subject of complexity. The associated risk with a diminished threshold for which intangibles to include is a sudden increase of reported intangibles based on an inaccurate assessment. This also includes exaggerated amortization cost and underreporting of figures in a tax-beneficial manner. Another immediate question is what to display. An unidentifiable intangible asset is a collective term including everything from data to leadership styles. Generalizing what to include in the balance sheets can be challenging due to industrial differences in the valuation of the different types of intangibles, suggesting that some assets are close to irrelevant in specific industries. The latter subject leads to another proposal for change.

### 5.4.3 Strategic Resource Planning

With the gradually increasing complexity and different types of intangible assets and trying to generalize a framework for all businesses in various industries, establishing a secondary report acts as an adjustment to these changes. As discussed in the CISOMAG (2019) article, firms could potentially rogue and report suspiciously high amounts of intangible assets to make up for deprivation in other areas. As a countermeasure, the suggestion is to implement a second balance sheet solely for intangibles. However, such an approach is nevertheless affected by the complexity of assessing the value of intangibles. Additionally, two separate balance sheets would require thorough inspection by internal accountants and external auditors, implying increased expenses correlated to this action. Lev and Gu (2016) points in the direction of the competitive framework and denotes that "*accounting-based financial reports provide information only on the final outcomes of asset deployment: revenue and earnings*" [p.125]. They further propose A Strategic Resource & Consequences Report that compromises five key attributes [p.121-126]: "inform investors about the strategic resources,

how they were acquired, the risk involved, the deployment of the assets, quantifying and report the consequences." The purpose of this reporting tool is to contemplate both tangible and intangible assets in a strategic perspective and thus consider them as either strategic or non-strategic resources. Porter (1985) states that strategic resources consist of attributes that state that they are valuable, rare, and difficult to imitate. This is in line with the suggestion of Haskel and Westlake (2018), which contemplates the 4 S's, which denotes that the critical properties of intangible assets consist of scalability, sunk cost, spillovers, and synergies. The general idea of strategic resource reporting is to deviate from the complexity of valuing intangibles by focusing on the value creation property of each asset. The purpose is to the best extent assigning all relevant information regarding the strategic resource in the report.

One trend that has become more relevant in recent years is the commerce of so-called non-fungible tokens (NFT), a unique digital certificate that states who is the owner of digital objects. These objects are primarily located in some sort of online media and contemplate a peripheral application. Its value is often determined through a bidding process, and its integrity is based on blockchain technology. Likewise, the EU Directive on Copyright in the Digital Single Market (Directive (EU) 2019/790, 2019), or popularized by its Draft Article 13, where prepared by the legislators to improve the "value gap" between content creators and the different internet platforms. The directive has faced extensive opposition from both users and internet platforms, and critics have pointed out this concerns the fundamental essence of the internet as an open platform available for everyone. Similar regulations have been implemented in the US. Most recognized the repeal of the FCC's net neutrality act (Collins, 2018), which imposes the internet providers more authority regarding the end-users access to the internet. These examples align with what Haskel and Westlake (2018) denote as an increasing issue with intangible assets, their spillovers. Should intangible assets be classified among the strategic resource report, preventing spillovers is essential in securing valuable, rare, and uncopiable attributes. This proposal's criticism is a definite reminder that the issues regarding intangible assets are complex and, therefore, an equilibrium might not be achievable. We believe the non-fungible tokens are advantageous as it is, as of now, not restricting the opensource principle contemplated in the fundamentals of the internet. However, we acknowledge the necessity of regulatory frameworks represented in this case by the EU directive.

A Strategic Resource & Consequences Report would induce a preferable condition for assessing the intangible assets withheld by the firm. Simultaneously, the importance of the

current accounting practices should not be neglected in the auditing process of the preceding performance of the firm. A sensible approach would be to consider both reports when reviewing the competitive ability of the firm. Recalling the level of consequences we introduce earlier in this study, which states that insufficient reporting of the actual value creation of the firm affects three different levels. The first one is the authority’s ability to assess the state of the economy accurately. The second level is the investor level and the consequences for the market dynamic. The third and last level, the enterprise itself and its ability to assess its competitive performance. The strategic resource report is more suitable for evaluating the firm-level of the proposed consequences as well as for the investors' perspective.

# 6. Conclusion

The reviewed literature regarding intangible assets and their effect on the current accounting practice has been a core inspirational source and hence assisted us in developing this study. Multiple approaches have been studied prior to the established methodology we have chosen to follow. Simultaneously, the literature has assisted us in achieving a greater perspective of the issues we have discussed. Our initial thought on the predicaments regarding intangible assets might have had minor implications regarding assessing the firm's competitive performance. Preliminary preparation of this thesis introduced ever more evidence that the related issues were considerably more complex and irruptive. Our proposed research question's primary motivation was to convince ourselves that current accounting practices might not be as relevant as we initially thought. Both authors of this study expect a career within the audit and consulting and, consequently, will most likely face some of the challenges discussed in this paper.

We conclude that the reviewed literature regarding the depreciated relevance of accounting also applies to the tested Norwegian market. Experiments performed both on the stock market, and the general sample of enterprises support this statement. Further experiments indicate that the stock market is positively valuing the reported intangibles. Additionally, the other experiments suggest that evermore of the firms' intangible assets are produced internally, and as of current accounting practices are not included in the reports. As a final statement, we recommend that the proposed solution introduced by Lev and Gu, the Strategic Resource & Consequences Report, should be considered a part of the official reporting criteria in addition to the current accounting practices. This proposal intends to increase the accuracy and interpretability of the value-creating activities for each firm—both for the enterprise's strategic perspective in a micro-environment and for the authorities in the macro-environment.

# References


Aghion, P., & Howitt, P. (1998). *Endogenous Growth Theory*. Cambridge, MA: MIT Press.

Alexakis, C., Patra, T., & Poshakwale, S. (2010). Predictability of Stock Returns using Financial Statement Information: Evdience on Semi-strong Efficency of Emerging Greek Stock Market. *Applied Financial Economics, 20*(16), 1321-1326.

Arrow, K. J. (1972). Economic Welfare and the Allocation of Resources for Invention. In C. K. Rowley (Ed.), *Readings in Industrial Economics: Volume Two: Private Enterprise and State Intervention* (pp. 219-236). London: Macmillan Education UK.

Ball, R., & Shivakumar, L. (2008). How Much New Information is there in Earnings? *Journal of Accounting Research, 46*, 65.

Barth, M. E., Kasznik, R., & McNichols, M. F. (2001). Analyst Coverage and Intangible Assets. *Journal of Accounting Research, 39*(1), 1-34. doi:https://doi.org/10.1111/1475-679X.00001

Baumol, W. J. (1966). *Performing arts : the economic dilemma*. Cambridge, Mass.

Baumol, W. J. (1996). Children of performing arts, the economic dilemma: The climbing costs of health care and education. *Journal of Cultural Economics, 20*(3), 183-206. doi:http://dx.doi.org/10.1007/s10824-005-3206-4

Beyer, A., Cohen, D. A., Lys, T. Z., & Walther, B. R. (2010). The financial reporting environment: Review of the recent literature. *Journal of Accounting and Economics, 50*(2-3), 296-343. doi:10.1016/j.jacceco.2010.10.003

Bjeregaard, A. P. (2020, 4th December ). Rush av IT-bedrifter på børs. *Finansavisen*, p. 6.

Bloom, M. (2009). Accounting For Goodwill. *Abacus, 45*(3), 379-389. doi:https://doi.org/10.1111/j.1467-6281.2009.00295.x

Bloom, N., Sadun, R., & Reenen, J. V. (2012). Americans Do IT Better: US Multinationals and the Productivity Miracle. *American Economic Review, 102*(1), 167-201. doi:10.1257/aer.102.1.167

Box, G. E. P., & Draper, N. R. (1987). *Empirical Model Building and Response Surfaces*: John Wiley & Sons.

Brynjolfsson, E., Hitt, L. M., Yang, S., Baily, M. N., & Hall, R. E. (2002). Intangible assets: Computers and organizational capital / Comments and discussion. *Brookings Papers on Economic Activity*(1), 137-198.

Chen, E., Gavious, I., & Lev, B. (2017). The positive externalities of IFRS R&D capitalization: enhanced voluntary disclosure. *Review of Accounting Studies, 22*(2), 677-714. doi:10.1007/s11142-017-9399-x

Choi, W. W., Kwon, S. S., & Lobo, G. J. (2000). Market Valuation of Intangible Assets. *Journal of Business Research, 49*(1), 35-45. doi:https://doi.org/10.1016/S0148-2963(98)00121-0

Christensen, B. H. (2018). *Anskaffelse og Implementering av forretningssystemer: Forretningsutvikling og gevinstrealisering i en digital tidsalder*. (16).

CISOMAG. (2019, May 31st, 2019). Should Data Go on Your Balance Sheet? Retrieved from https://cisomag.eccouncil.org/should-data-go-on-your-balance-sheet/

Cohen, R. B., Gompers, P. A., & Vuolteenaho, T. (2002). Who underreacts to cash-flow news? evidence from trading between individuals and institutions. *Journal of Financial Economics, 66*(2), 409-462. doi:https://doi.org/10.1016/S0304-405X(02)00229-5

Collins, K. (2018, June 11). The Net Neutrality Repeal Is Official. *New York Times*. Retrieved from https://www.nytimes.com/2018/06/11/technology/net-neutrality-repeal.html

Corrado, C., Haskel, J., Jona-Lasinio, C., & Iommi, M. (2013). Innovation and intangible investment in Europe, Japan, and the United States. *Oxford Review of Economic Policy, 29*(2), 261-286. doi:10.1093/oxrep/grt017

Corrado, C. A., & Hulten, C. R. (2010). How Do You Measure a "Technological Revolution"? *The American Economic Review, 100*(2), 99-104.

Corrado, C. A., Hulten, C. R., & Sichel, D. (2005). Measuring Capital and Technology: An Expanded Framework. In C. A. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring Capital in the New Economy* University of Chicago Press.

DESI. (2020). *Digital Economy and Society Index (DESI) 2020*. Retrieved from European Commision: https://digital-strategy.ec.europa.eu/en/policies/desi

DeVault, G. (2020, December 5th, 2020). Here Are the Advantages and Disadvantages of Quantitative Research. Retrieved from https://www.thebalancesmb.com/quantitative-research-advantages-and-disadvantages-2296728

Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on copyright and related rights in the Digital Single Market and amending Directives 96/9/EC and 2001/29/EC, 2019/790 C.F.R. (2019).

Dixit, A. (1992). Investment and Hysteresis. *The Journal of Economic Perspectives, 6*(1), 107-132.

Dixit, A. K., & Pindyck, R. S. (1995). The Options Approach to Capital Investment. *Harvard Business Review, 73*(3), 105-115.

Encyclopedia of Research Design. (2010). doi:10.4135/9781412961288

Fidelity. (2021). Sectors & Industries Overview Retrieved from https://eresearch.fidelity.com/eresearch/markets_sectors/sectors/sectors_in_market.jhtml

Fredriksen, A. W., & Johansen, E. (2015, June 12th, 2015). Derfor er det krise i oljebransjen. Retrieved from https://e24.no/olje-og-energi/i/6nGvGo/derfor-er-det-krise-i-oljebransjen

Glaeser, E. L., Kallal, H. D., Scheinkman, J., xe, A, & Shleifer, A. (1992). Growth in Cities. *Journal of Political Economy, 100*(6), 1126-1152.

Graham, B., & Dodd, D. L. (1951). *Security Analysis: Principles and Techniques* (3rd ed.): McGraw-Hill.

Griliches, Z. (1992). The Search for R&D Spillovers. *The Scandinavian Journal of Economics, 94*, S29-S47. doi:10.2307/3440244

Harrison, J. M., & Kreps, D. M. (1978). SPECULATIVE INVESTOR BEHAVIOR IN A STOCK MARKET WITH HETEROGENEOUS EXPECTATIONS. *Quarterly Journal of Economics, 92*(2), 323-336. doi:10.2307/1884166

Haskel, J., & Westlake, S. (2018). *Capitalism Without Capital*: Princeton University Press.

Hodge, J. (2019, July 2nd, 2019). Data is Our Greates Asset - So Why Can't We Find It? Retrieved from https://techmonitor.ai/techonology/data/data-is-our-greatest-asset

Hong, H., Scheinkman, J., & Xiong, W. E. I. (2006). Asset Float and Speculative Bubbles. *The Journal of Finance, 61*(3), 1073-1117. doi:https://doi.org/10.1111/j.1540-6261.2006.00867.x

Hong, H., & Stein, J. C. (1999). A Unified Theory of Underreaction, Momentum Trading, and Overreaction in Asset Markets. *The Journal of Finance, 54*(6), 2143-2184. doi:https://doi.org/10.1111/0022-1082.00184

Hulten, C. R. (2010). *Decoding Microsoft: Intangible Capital as a Source of Company Growth* (Working Paper no. 15799). Retrieved from

IAASB. (2011). *The Evolving Nature of Financial Reporting: Disclosure and Its Audit Implications*. Retrieved from

Jagannath, A., & Koller, T. (2013). Building a Better Income Statement. *McKinsey Corporte, Corporate Finance*.
James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning with Application in R* (1 ed.). New York: Springer
Jennings, R., Robinson, J., Thompson Ii, R. B., & Duvall, L. (1996). THE RELATION BETWEEN ACCOUNTING GOODWILL NUMBERS AND EQUITY VALUES. *Journal of Business Finance & Accounting, 23*(4), 513-533. doi:10.1111/j.1468-5957.1996.tb01024.x
Jones, C. I. (1996). Human Capital, Ideas, and Economic Growth. (VIII Villa Mondragone International Economic Seminar on Finance, Research, Education, and Growth).
Khan, M., & Watts, R. L. (2009). Estimation and empirical properties of a firm-year measure of accounting conservatism. *Journal of Accounting and Economics, 48*(2-3), 132-150. doi:10.1016/j.jacceco.2009.08.002
Kim, J.-B., & Zhang, L. (2016). Accounting Conservatism and Stock Price Crash Risk: Firm-level Evidence. *Contemporary Accounting Research, 33*(1), 412-441. doi:10.1111/1911-3846.12112
Lev, B. (2001). *Intangibles Management, Measurement, and Reporting*: Brookings Institution Press.
Lev, B., & Gu, F. (2016). *The End of Accounting And The Path Forward For Investros and Managers* John Wiley & Sons, Inc.
Lev, B., Li, S., & Sougiannis, T. (2010). The usefulness of accounting estimates for predicting cash flows and earnings. *Review of Accounting Studies, 15*(4), 779-807. doi:10.1007/s11142-009-9107-6
Martinez, I. (1999). Fundamental and macroeconomic information for the security prices valuation: the French case. *Managerial Finance, 25*(12), 17-30. doi:10.1108/03074359910766316
Nakamura, L. I. (2001). *What is the U.S. gross investment in intangibles? (At least) one trillion dollars a year!* Retrieved from https://ideas.repec.org/p/fip/fedpwp/01-15.html
OECD. (1998). *Measuring Intangible Investment*. Retrieved from https://www.oecd.org/sti/ind/1943317.pdf
Oslo Børs. (2021). Equities. Retrieved from https://www.oslobors.no/ob_eng/Oslo-Boers/Statistics/Annual-statistics/Equities/(year)/2019?fbclid=IwAR0QlJ4Cz46ylrBQazXPfEUnPf31e4Tgr44hzjva8rFifW6zNA9WjcaXaF8
Porter, M. E. (1985). *Competitive advantage : creating and sustaining superior performance*. New York: Free Press.
Ratvig, H. J., & Svergja, K. (2016). *Innovation in Recession: Effetcs on Firm Performance* (Master Thesis ), NHH Norwegian School of Economics
Lov om årsregnskap, LOV-1998-07-17-56 C.F.R. (1998).
Regnskapsstiftelsen. (2012). *Norsk Regnskapsstandard 19: Immatrielle eiendeler* (NRS19). Retrieved from
Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy, 98*(5), S71-S102. doi:10.1086/261725
Romer, P. M. (1994). The Origins of Endogenous Growth. *The Journal of Economic Perspectives, 8*(1), 3-22.
Saunders, M. N. K., Lewis, P., & Thornhill, A. (2019). *Research methods for business students*.
Scheinkman, J. A., & Wei, X. (2003). Overconfidence and Speculative Bubbles. *Journal of Political Economy, 111*(6), 1183-1219. doi:10.1086/378531

SEC. (2011). A Comparison of U.S. GAAP and IFRS *Work Plan for the Consideration of Incorporating International Financial Reporting System for U.S. Issuers*.

Shannon, C. E., & Weaver, W. (1949). The Mathematical Theory of Communication *The Univeristy of Illonois Press*.

Sherman, D. H., & Young, D. S. (2018). The Pitfalls of Non-GAAP Metrics. *MIT Sloan Management Review*(Winter).

Silver, N. (2012). *The signal and the noise: Why so many predictions fail--but some don't.* New York: Penguin Press.

Statistics Norway. (2009). Classification of Standard Industrial Classification. Retrieved from https://www.ssb.no/en/klass/klassifikasjoner/6

Stuart, R. (2020). *U.S. GAAP vs. IFRS: Intangible assets other than goodwill* Retrieved from

Wilcoxon, F. (1945). Individual Comparisons by Ranking Methods. *Biometrics Bulletin, 1*(6), 80-83. doi:10.2307/3001968

Xia, Y. (2020). Chapter Eleven - Correlation and association analyses in microbiome study integrating multiomics in health and disease. In J. Sun (Ed.), *Progress in Molecular Biology and Translational Science* (Vol. 171, pp. 309-491): Academic Press.

Young, A. (1998). *Towards an Interim Statistical Framework: Selecting the Core Components of Intangible Investment*. Retrieved from

# Appendix

## [1] Data from SNF

Accounting variables included in the data set are primarily categorized in three segments: *Income Statement*, *Balance*, and *Generated Variables.* A comprehensive review of the included variables and the data set collectively can be found in the Working Paper 15/15 “Documentation and quality assurance of SNF's and NHH's database on accounting and company information for Norwegian companies”.

Tabular displacement of the data set:

| Organization Number | Name of enterprise | Accounting figures (N number of variables |
|---|---|---|
| | | Number of variables fluctuates in accordance with the applicable accounting practice for that particular year |
| | | |
| | | |
| | | |
| | | |
| | | |

# [2] NACE codes

Tabular summary of the excluded industry codes

| NACE SN02 | NACE SN07 | Industry name |
|---|---|---|
| 1 | 1 | Crop and animal production, hunting and related service activities |
| 2 | 2 | Forestry and logging |
| 50 | 45 | Wholesale and retail trade and repair of motor vehicles and motorcycles |
| 52 | 47 | Retail trade, except of motor vehicles and motorcycles |
| 65 | 65 | Insurance, reinsurance and pension funding, except compulsory social security |
| 66 | 66 | Activities auxiliary to financial services and insurance activities |
| 70 | 68 | Retail estate activities |
| 741 | 69 | Legal and accounting activities |
| 744 | 73 | Advertising and market research |
| - | 75 | Veterinary activities |
| 71 | 77 | Rental and leasing activities |
| 745 | 78 | Employment activities |
| - | 79 | Travel agency, tour operator and other reservation service and related activities |
| 746 | 80 | Security and investigation activities |
| 747 | 81 | Services to buildings and landscape activities |
| 80 | 85 | Education |
| 92 | 90 | Creative, arts and entertainment activities |
| 92 | 91 | Liberian, archives, museums, and other cultural activities |
| 92 | 92 | Gambling and betting activities |
| 99 | 99 | Activities of extraterritorial organizations and bodies |

# [3] Cross-sectional Matching Procedure

Year 20XX – Test Portfolio

| Firm ID | Industry | PIA | TA | BE | EBX | BM |
|---|---|---|---|---|---|---|
| …. | | | | | | |
| …. | | | | | | |
| …. | | | | | | |
| …. | | | | | | |

| Experimental Portfolio | | Control Portfolio | |
|---|---|---|---|
| Firm ID | Industry | Firm ID | Industry |
| …. | K | …. | K |
| …. | K | …. | K |
| | | ….. | K |
| | | ….. | K |

| Experimental Portfolio | | Control Portfolio | |
|---|---|---|---|
| Firm ID | Industry | Firm ID | Industry |
| …. | M | …. | M |
| …. | M | …. | M |
| …. | M | ….. | M |
| | M | | |
| | M | | |

20XX – Industry M - BE values

| Experimental Portfolio | Control Portfolio |
|---|---|
| …. | …. |
| …. | …. |
| …. | …. |

Mean value

| Mean | Mean |
|---|---|

Test Objective

| Test Group | Experimental Portfolio | Control Portfolio |
|---|---|---|
| 2010_M | Mean | Mean |
| 2011_M | | |
| 2010_K | | |
| …. | | |

# [4] Experiment 1: OLS Regression Results

**2010**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 6159000 | 3273000 | 1.8810 | 0.0650 |
| NI | 8.2740 | 3.3660 | 2.4580 | 0.0170 |
| BE | 0.8830 | 0.9220 | 0.9580 | 0.3430 |
| NHS | -0.0160 | 0.0240 | -0.6530 | 0.5170 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.89 | | |
| F-value | 152.398 | p-value | 0.1000 |
| N | 57 | | |

**2011**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 6704000 | 3133000 | 2.1400 | 0.0370 |
| NI | 4.5190 | 0.9650 | 4.6810 | 0.0000 |
| BE | 0.4960 | 0.3050 | 1.6240 | 0.1100 |
| NHS | 0.0040 | 0.0120 | 0.3230 | 0.7480 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.878 | | |
| F-value | 147.515 | p-value | 0.8000 |
| N | 62 | | |

**2012**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 6485000 | 2941000 | 2.2050 | 0.0310 |
| NI | 4.4680 | 1.1810 | 3.7820 | 0.0000 |
| BE | 0.3940 | 0.3400 | 1.1560 | 0.2520 |
| NHS | 0.0080 | 0.0120 | 0.6480 | 0.5190 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.865 | | |
| F-value | 147.943 | p-value | 0.6000 |
| N | 70 | | |

**2013**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 6519000 | 2496000 | 2.6120 | 0.0110 |
| NI | 22.8000 | 2.9160 | 7.8160 | 0.0000 |
| BE | -1.5790 | 0.3990 | -3.9550 | 0.0000 |
| NHS | 0.0210 | 0.0080 | 2.6560 | 0.0100 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.89 | Studentized Breusch-Pagan test | |
| F-value | 206.307 | p-value | 0.0090 |
| N | 77 | | |

**2014**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 5777000 | 3171000 | 1.8220 | 0.0720 |
| NI | 4.0390 | 1.4090 | 2.8660 | 0.0050 |
| BE | 1.1090 | 0.1130 | 9.8080 | 0.0000 |
| NHS | 0.0010 | 0.0090 | 0.0830 | 0.9340 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.81 | Studentized Breusch-Pagan test | |
| F-value | 113.604 | p-value | 0.0800 |
| N | 80 | | |

**2015**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 3937000 | 2174000 | 1.8110 | 0.0730 |
| NI | 0.1680 | 0.5610 | 0.2990 | 0.7650 |
| BE | 1.3040 | 0.0800 | 16.3700 | 0.0000 |
| NHS | - | - | - | - |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.788 | Studentized Breusch-Pagan test | |
| F-value | 216.626 | p-value | 0.3000 |
| N | 117 | | |

F

**2016**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 5184000 | 2012000 | 2.5760 | 0.0110 |
| NI | -0.0650 | 0.7660 | -0.0840 | 0.9330 |
| BE | 1.4590 | 0.0680 | 21.4500 | 0.0000 |
| NHS | -0.0010 | 0.0020 | -0.3230 | 0.7470 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.83 | Studentized Breusch-Pagan test | |
| F-value | 182.025 | p-value | 0.2000 |
| N | 112 | | |

**2017**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 6156000 | 2276000 | 2.7050 | 0.0080 |
| NI | 6.9210 | 2.0840 | 3.3210 | 0.0010 |
| BE | 0.4910 | 0.2940 | 1.6710 | 0.0970 |
| NHS | 0.0030 | 0.0050 | 0.5780 | 0.5640 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.784 | Studentized Breusch-Pagan test | |
| F-value | 148.211 | p-value | 0.0500 |
| N | 123 | | |

**2018**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 4801000 | 2001000 | 2.3990 | 0.0180 |
| NI | 5.9860 | 1.3240 | 4.5220 | 0.0000 |
| BE | 0.7610 | 0.2130 | 3.5710 | 0.0000 |
| NHS | 0.0040 | 0.0050 | 0.7900 | 0.4310 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.86 | Studentized Breusch-Pagan test | |
| F-value | 270.251 | p-value | 0.0200 |
| N | 133 | | |

# [5] Experiment 1: Revised OLS Regression Results

**2010**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 5912000 | 3517000 | 1.6810 | 0.0990 |
| NI | 8.3070 | 3.4960 | 2.3760 | 0.0210 |
| BE | 1.1110 | 1.1870 | 0.9360 | 0.3540 |
| NHS | -0.0210 | 0.0300 | -0.6960 | 0.4890 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.3630 | | |
| F-value | 10.8570 | p-value | 0.0005 |
| N | 53 | | |

**2011**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 5079000 | 3210000 | 1.5820 | 0.1190 |
| NI | 13.8700 | 3.7450 | 3.7030 | 0.0010 |
| BE | -0.4670 | 0.4760 | -0.9810 | 0.3310 |
| NHS | 0.0320 | 0.0160 | 2.0050 | 0.0500 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.4270 | | |
| F-value | 15.1800 | p-value | 0.2000 |
| N | 58 | | |

**2012**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 143700 | 2754000 | 0.0520 | 0.9590 |
| NI | 25.2900 | 3.7160 | 6.8070 | 0.0000 |
| BE | -2.2320 | 0.5330 | -4.1860 | 0.0000 |
| NHS | 0.0940 | 0.0180 | 5.2110 | 0.0000 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.6100 | | |
| F-value | 34.3840 | p-value | 0.0030 |
| N | 65 | | |

**2013**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 3770000 | 2528000 | 1.4910 | 0.1410 |
| NI | 26.0000 | 2.8730 | 9.0480 | 0.0000 |
| BE | -1.5590 | 0.3710 | -4.2040 | 0.0000 |
| NHS | 0.0270 | 0.0080 | 3.4990 | 0.0010 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.7290 | Studentized Breusch-Pagan test | |
| F-value | 61.2290 | p-value | 0.0020 |
| N | 68 | | |

**2014**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 6195000 | 3492000 | 1.7740 | 0.0810 |
| NI | 8.0670 | 2.3480 | 3.4360 | 0.0010 |
| BE | 0.3760 | 0.3720 | 1.0110 | 0.3160 |
| NHS | 0.0030 | 0.0090 | 0.3160 | 0.7530 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.4860 | Studentized Breusch-Pagan test | |
| F-value | 22.7080 | p-value | 0.0400 |
| N | 70 | | |

**2015**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 5115000 | 2135000 | 2.3960 | 0.0180 |
| NI | 13.8100 | 2.4770 | 5.5760 | 0.0000 |
| BE | -0.5530 | 0.3380 | -1.6370 | 0.1050 |
| NHS | - | - | - | - |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.5280 | Studentized Breusch-Pagan test | |
| F-value | 58.7250 | p-value | 0.0000 |
| N | 104 | | |

**2016**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 4490000 | 1600000 | 2.8060 | 0.0060 |
| NI | 21.4100 | 2.2820 | 9.3860 | 0.0000 |
| BE | -0.7410 | 0.2310 | -3.2030 | 0.0020 |
| NHS | -0.0010 | 0.0020 | -0.5290 | 0.5980 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.7590 | Studentized Breusch-Pagan test | |
| F-value | 102.878 | p-value | 0.0000 |
| N | 98 | | |

**2017**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 3941000 | 2475000 | 1.5930 | 0.1140 |
| NI | 11.0700 | 2.4130 | 4.5880 | 0.0000 |
| BE | 0.3430 | 0.2990 | 1.1480 | 0.2540 |
| NHS | 0.0100 | 0.0060 | 1.7240 | 0.0880 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.5830 | Studentized Breusch-Pagan test | |
| F-value | 51.38 | p-value | 0.0030 |
| N | 109 | | |

**2018**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 5161000 | 2251000 | 2.2930 | 0.0240 |
| NI | 5.4210 | 1.7950 | 3.0200 | 0.0030 |
| BE | 0.7380 | 0.2320 | 3.1840 | 0.0020 |
| NHS | 0.0040 | 0.0060 | 0.6260 | 0.5330 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.4930 | Studentized Breusch-Pagan test | |
| F-value | 39.2200 | p-value | 0.0007 |
| N | 119 | | |

# [6] Experiment 1: Correlation Matrix

## Correlation Matrix – normal sampling

**2010**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.95 | 0.93 | 0.85 |
| NI | | 1.00 | 0.98 | 0.89 |
| BE | | | 1.00 | 0.95 |
| NHS | | | | 1.00 |

**2011**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.93 | 0.92 | 0.79 |
| NI | | 1.00 | 0.95 | 0.79 |
| BE | | | 1.00 | 0.87 |
| NHS | | | | 1.00 |

**2012**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.93 | 0.92 | 0.77 |
| NI | | 1.00 | 0.96 | 0.78 |
| BE | | | 1.00 | 0.86 |
| NHS | | | | 1.00 |

**2013**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.93 | 0.90 | 0.62 |
| NI | | 1.00 | 0.98 | 0.65 |
| BE | | | 1.00 | 0.74 |
| NHS | | | | 1.00 |

**2014**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.60 | 0.89 | 0.63 |
| NI | | 1.00 | 0.54 | 0.28 |
| BE | | | 1.00 | 0.72 |
| NHS | | | | 1.00 |

**2015**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | -0.55 | 0.89 | NA |
| NI | | 1.00 | -0.63 | NA |
| BE | | | 1.00 | NA |
| NHS | | | | NA |

**2016**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | -0.30 | 0.91 | 0.26 |
| NI | | 1.00 | -0.32 | -0.18 |
| BE | | | 1.00 | 0.30 |
| NHS | | | | 1.00 |

**2017**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.88 | 0.88 | 0.47 |
| NI | | 1.00 | 0.97 | 0.47 |
| BE | | | 1.00 | 0.55 |
| NHS | | | | 1.00 |

**2018**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.92 | 0.92 | 0.59 |
| NI | | 1.00 | 0.96 | 0.58 |
| BE | | | 1.00 | 0.63 |
| NHS | | | | 1.00 |

## Correlation Matrix – without petroleum industry

**2010**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.62 | 0.52 | 0.35 |
| NI | | 1.00 | 0.76 | 0.53 |
| BE | | | 1.00 | 0.88 |
| NHS | | | | 1.00 |

**2011**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.64 | 0.56 | 0.26 |
| NI | | 1.00 | 0.78 | 0.09 |
| BE | | | 1.00 | 0.57 |
| NHS | | | | 1.00 |

**2012**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.68 | 0.58 | 0.24 |
| NI | | 1.00 | 0.80 | -0.01 |
| BE | | | 1.00 | 0.53 |
| NHS | | | | 1.00 |

**2013**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.82 | 0.63 | 0.13 |
| NI | | 1.00 | 0.87 | 0.07 |
| BE | | | 1.00 | 0.36 |
| NHS | | | | 1.00 |

**2014**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.70 | 0.65 | 0.18 |
| NI | | 1.00 | 0.84 | 0.16 |
| BE | | | 1.00 | 0.35 |
| NHS | | | | 1.00 |

**2015**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.72 | 0.63 | NA |
| NI | | 1.00 | 0.93 | NA |
| BE | | | 1.00 | NA |
| NHS | | | | NA |

**2016**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.86 | 0.74 | 0.03 |
| NI | | 1.00 | 0.93 | 0.08 |
| BE | | | 1.00 | 0.09 |
| NHS | | | | 1.00 |

**2017**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.75 | 0.72 | 0.13 |
| NI | | 1.00 | 0.86 | -0.04 |
| BE | | | 1.00 | 0.19 |
| NHS | | | | 1.00 |

**2018**

| | MV | NI | BE | NHS |
|---|---|---|---|---|
| MV | 1.00 | 0.67 | 0.68 | 0.13 |
| NI | | 1.00 | 0.81 | 0.01 |
| BE | | | 1.00 | 0.23 |
| NHS | | | | 1.00 |

# [7] Experiment 3: Mean Values MVBSH

**2012**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.2686 | | |
| TA | 2,258,056 | 1,551,719 | 13,791,130 |
| BE | 652,818 | -53,519 | 2,078,155 |
| EBX | 221,038 | 221,038 | 45,231 |
| BM | 0.2837 | 0.1482 | 1.2076 |

**2013**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.2342 | | |
| TA | 2,277,774 | 1,529,895 | 13,432,047 |
| BE | 753,658 | 5,779 | 1,953,950 |
| EBX | 300,831 | 300,831 | 78,338 |
| BM | 0.4157 | 0.2598 | 1.2892 |

**2014**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.2349 | | |
| TA | 2,157,163 | 1,324,078 | 13,985,336 |
| BE | 717,068 | 116,018 | 2,435,878 |
| EBX | 185,787 | 185,787 | 213,751 |
| BM | 0.3837 | 0.2407 | 0.0795 |

**2015**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.2512 | | |
| TA | 2,701,502 | 1,602,952 | 5,350,013 |
| BE | 946,910 | 151,640 | 1,835,055 |
| EBX | 5,976 | 5,976 | 319,040 |
| BM | 0.3499 | 0.1788 | 1.2432 |

**2016**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.2708 | | |
| TA | 13,961,758 | 9,342,227 | 11,845,207 |
| BE | 3,383,370 | 1,236,161 | 3,776,921 |
| EBX | 270,509 | 270,509 | 366,056 |
| BM | 0.2164 | 0.0366 | 0.6900 |

**2017**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.2555 | | |
| TA | 13,172,373 | 9,412,198 | 9,906,301 |
| BE | 3,458,583 | 301,592 | 3,107,461 |
| EBX | 809,207 | 809,207 | 63,331 |
| BM | 0.1716 | 0.0544 | 0.2888 |

**2018**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.2402 | | |
| TA | 11,487,269 | 7,831,837 | 8,511,816 |
| BE | 3,223,561 | -431,871 | 2,509,520 |
| EBX | 944,596 | 944,596 | 5,190 |
| BM | 0.2119 | 0.0834 | 0.2156 |

# [8] Wilcoxon Signed Ranked t-test MVBSH

| | Mean Value | | | p-value from Paired t-Test | |
|---|---|---|---|---|---|
| Variables | Experimental | Adjusted | Control | Experimental-Control | Adjusted-Control |
| PIA | 0.2502 | | | | |
| TA | 7895531 | 5392463 | 10387941 | 0.8117 | 0.7593 |
| BE | 2148870 | -354199 | 2646501 | 0.5854 | 0.0000 |
| EBX | 467090 | 467090 | 102869 | 0.0460 | 0.0460 |
| BM | 0.2743 | 0.1300 | 0.6103 | 0.1678 | 0.0290 |

# [9] Experiment 3: Mean Values ABSH

**2001**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3127 | | |
| TA | 74,488 | 42,977 | 28,367 |
| BE | 25,879 | 5,632 | 10,140 |
| EBX | 214 | 214 | 1084 |

**2002**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3269 | | |
| TA | 90,790 | 55,495 | 24,972 |
| BE | 33,247 | 2,048 | 9,072 |
| EBX | 1001 | 1001 | 397 |

**2003**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3303 | | |
| TA | 87,496 | 53,434 | 26,552 |
| BE | 31,897 | 2,165 | 10,606 |
| EBX | 62 | 62 | 493 |

**2004**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3466 | | |
| TA | 84,707 | 54,203 | 34,647 |
| BE | 29,155 | 1,349 | 14,747 |
| EBX | 607 | 607 | 1,691 |

**2005**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3397 | | |
| TA | 81,309 | 51,015 | 40,395 |
| BE | 28,573 | 1,721 | 16,991 |
| EBX | 2,500 | 2,500 | 3,441 |

N

**2006**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3347 | | |
| TA | 114,532 | 75,714 | 34,844 |
| BE | 39,972 | 1,154 | 15,327 |
| EBX | 6,315 | 6,315 | 2,819 |

**2007**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3369 | | |
| TA | 106,363 | 68,769 | 36,231 |
| BE | 37,942 | 347 | 15,283 |
| EBX | 3,955 | 3,955 | 2,484 |

**2008**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3307 | | |
| TA | 103,268 | 65,428 | 40,095 |
| BE | 36,117 | 1,723 | 16,215 |
| EBX | 4,408 | 4,408 | 1,782 |

**2009**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3544 | | |
| TA | 126,091 | 80,570 | 45,219 |
| BE | 39,491 | 6,030 | 21,186 |
| EBX | 4,092 | 4,092 | 2,357 |

**2010**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3751 | | |
| TA | 126,433 | 82,543 | 52,197 |
| BE | 40,704 | 3,187 | 21,833 |
| EBX | 5,919 | 5,919 | 2,271 |

**2011**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.3780 | | |
| TA | 148,008 | 97,462 | 49,865 |
| BE | 49,097 | 1,449 | 22,240 |
| EBX | 6,999 | 6,999 | 432 |

**2012**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.4025 | | |
| TA | 144,982 | 89,776 | 60,453 |
| BE | 45,692 | 9,514 | 24,137 |
| EBX | 3,031 | 3,031 | 1,794 |

**2013**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.4100 | | |
| TA | 156,957 | 96,487 | 67,725 |
| BE | 47,829 | 12,642 | 24,865 |
| EBX | 4,597 | 4,597 | 2,323 |

**2014**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.4159 | | |
| TA | 190,656 | 117,230 | 50,337 |
| BE | 48,757 | 24,670 | 15,698 |
| EBX | 1,302 | 1,302 | 1,050 |

**2015**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.4270 | | |
| TA | 247,892 | 164,601 | 919,875 |
| BE | 63,880 | 19,411 | 55,853 |
| EBX | 336 | 336 | 1,247 |

**2016**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.4274 | | |
| TA | 192,125 | 116,418 | 50,071 |
| BE | 54,482 | 21,225 | 21,494 |
| EBX | 6,215 | 6,215 | 1,371 |

**2017**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.4330 | | |
| TA | 222,718 | 138,313 | 42,081 |
| BE | 62,988 | 21,417 | 21,999 |
| EBX | 10,335 | 10,335 | 2,132 |

**2018**

| Variables | Experimental | Adjusted | Control |
|---|---|---|---|
| PIA | 0.4433 | | |
| TA | 201,962 | 120,819 | 48,546 |
| BE | 64,858 | 16,285 | 30,898 |
| EBX | 11,598 | 11,598 | 369 |

# [10] Wilcoxon Signed Ranked t-test ABSH

| | Mean Value | | | p-value from Paired t-Test | |
|---|---|---|---|---|---|
| Variables | Experimental | Adjusted | Control | Experimental-Control | Adjusted-Control |
| PIA | 0.3870 | | | | |
| TA | 154255 | 96718 | 115578 | 0.0000 | 0.0019 |
| BE | 46919 | -10618 | 23280 | 0.0003 | 0.0000 |
| EBX | 4686 | 4686 | 1580 | 0.0012 | 0.0012 |

# [11] Experiment 3: OLS Regression Analysis

**2010**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 636400 | 1496000 | 0.4250 | 0.6720 |
| ABPI | 1.8920 | 0.1210 | 15.6000 | 0.0000 |
| PPE | 16.6400 | 1.4700 | 11.3100 | 0.0000 |
| IA | 7.2610 | 3.8950 | 1.8640 | 0.0670 |
| LAIB | -2.0000 | 0.1720 | -11.6400 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.962 | Studentized Breusch-Pagan test | |
| F-value | 455.399 | p-value | 0.8 |
| N | 72 | | |

**2011**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 455000 | 1470000 | 0.3090 | 0.7580 |
| ABPI | 1.4930 | 0.1020 | 14.5900 | 0.0000 |
| PPE | 14.0300 | 1.3830 | 10.1400 | 0.0000 |
| IA | 11.8400 | 3.6170 | 3.2730 | 0.0020 |
| LAIB | -1.5960 | 0.1040 | -15.3000 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9560 | Studentized Breusch-Pagan test | |
| F-value | 412.4560 | p-value | 1.0000 |
| N | 77 | | |

**2012**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1178000 | 1337000 | 0.8810 | 0.3810 |
| ABPI | 1.4950 | 0.0420 | 35.6800 | 0.0000 |
| PPE | 15.3900 | 1.1720 | 13.1400 | 0.0000 |
| IA | 5.6380 | 3.8710 | 1.4570 | 0.1490 |
| LAIB | -1.5900 | 0.0470 | -34.0400 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9600 | Studentized Breusch-Pagan test | |
| F-value | 491.9570 | p-value | 1.0000 |
| N | 83 | | |

R

**2013**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 318988 | 820102 | 0.3890 | 0.6980 |
| ABPI | 1.1710 | 0.0400 | 29.3090 | 0.0000 |
| PPE | 16.9180 | 0.6520 | 25.9430 | 0.0000 |
| IA | 7.1010 | 1.8090 | 3.9260 | 0.0000 |
| LAIB | -1.2400 | 0.0380 | -32.8190 | 0.0000 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9840 | | |
| F-value | 1312.3230 | p-value | 0.1000 |
| N | 88 | | |

**2014**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1626000 | 726400 | 2.2380 | 0.0280 |
| ABPI | 1.0540 | 0.0580 | 18.3300 | 0.0000 |
| PPE | 18.0900 | 0.5620 | 32.2000 | 0.0000 |
| IA | 0.3280 | 1.1820 | 0.2780 | 0.7820 |
| LAIB | -1.0970 | 0.0580 | -18.8200 | 0.0000 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9840 | | |
| F-value | 1469.7380 | p-value | 0.3000 |
| N | 99 | | |

**2015**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1574000 | 730600 | 2.1550 | 0.0330 |
| ABPI | 1.1090 | 0.0520 | 21.5100 | 0.0000 |
| PPE | 17.4000 | 0.5840 | 29.7800 | 0.0000 |
| IA | 2.2200 | 1.1610 | 1.9120 | 0.0590 |
| LAIB | -1.1790 | 0.0510 | -22.9000 | 0.0000 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9790 | | |
| F-value | 1268.7140 | p-value | 0.0700 |
| N | 108 | | |

**2016**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 2364000 | 1004000 | 2.3550 | 0.0200 |
| ABPI | 1.7290 | 0.0480 | 36.3400 | 0.0000 |
| PPE | 13.1400 | 0.7430 | 17.6800 | 0.0000 |
| IA | -11.2500 | 0.9750 | -11.5400 | 0.0000 |
| LAIB | -1.7810 | 0.0530 | -33.3900 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9490 | Studentized Breusch-Pagan test | |
| F-value | 556.3460 | p-value | 0.1000 |
| N | 120 | | |

**2017**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 3016000 | 1151000 | 2.6200 | 0.0100 |
| ABPI | 1.4710 | 0.0500 | 29.2900 | 0.0000 |
| PPE | 16.5200 | 0.9140 | 18.0700 | 0.0000 |
| IA | -18.7100 | 1.4010 | -13.3500 | 0.0000 |
| LAIB | -1.4130 | 0.0560 | -25.1400 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9260 | Studentized Breusch-Pagan test | |
| F-value | 425.3320 | p-value | 0.1000 |
| N | 136 | | |

**2018**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1935000 | 1067000 | 1.8140 | 0.0720 |
| ABPI | 2.0410 | 0.0490 | 41.4000 | 0.0000 |
| PPE | 13.9200 | 0.7980 | 17.4500 | 0.0000 |
| IA | -12.2600 | 1.1150 | -10.9900 | 0.0000 |
| LAIB | -2.1290 | 0.0560 | -37.8900 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9450 | Studentized Breusch-Pagan test | |
| F-value | 634.3880 | p-value | 0.3000 |
| N | 148 | | |

# [12] Experiment 3: Revised OLS Regression Results

**2010**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 2390000 | 1595000 | 1.4980 | 0.1390 |
| ABPI | 1.4570 | 0.1950 | 7.4710 | 0.0000 |
| PPE | 16.6600 | 1.4730 | 11.3100 | 0.0000 |
| IA | 4.6720 | 4.2430 | 1.1010 | 0.2750 |
| LAIB | -1.5810 | 0.2240 | -7.0560 | 0.0000 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.8090 | | |
| F-value | 72.0640 | p-value | 0.9000 |
| N | 68 | | |

**2011**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 2343000 | 1450000 | 1.6160 | 0.1110 |
| ABPI | 0.9610 | 0.1660 | 5.7860 | 0.0000 |
| PPE | 15.2500 | 1.3380 | 11.4000 | 0.0000 |
| IA | 4.0580 | 4.0700 | 0.9970 | 0.3220 |
| LAIB | -1.0210 | 0.1760 | -5.7880 | 0.0000 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.8120 | | |
| F-value | 79.8720 | p-value | 1.0000 |
| N | 74 | | |

**2012**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 2324000 | 1334000 | 1.7430 | 0.0850 |
| ABPI | 0.9970 | 0.1660 | 6.0100 | 0.0000 |
| PPE | 15.1200 | 1.1220 | 13.4800 | 0.0000 |
| IA | 5.3580 | 3.6970 | 1.4490 | 0.1510 |
| LAIB | -1.0620 | 0.1760 | -6.0240 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.8440 | Studentized Breusch-Pagan test | |
| F-value | 108.9240 | p-value | 0.9000 |
| N | 81 | | |

**2013**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 768829 | 865906 | 0.8880 | 0.3770 |
| ABPI | 1.0090 | 0.1120 | 8.9870 | 0.0000 |
| PPE | 16.9260 | 0.6500 | 26.0340 | 0.0000 |
| IA | 5.9880 | 1.9390 | 3.0880 | 0.0030 |
| LAIB | -1.0630 | 0.1200 | -8.8450 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9500 | Studentized Breusch-Pagan test | |
| F-value | 400.9270 | p-value | 0.1000 |
| N | 86 | | |

**2014**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 358450 | 700598 | 0.5120 | 0.6100 |
| ABPI | 1.4520 | 0.0980 | 14.8860 | 0.0000 |
| PPE | 18.0210 | 0.5020 | 35.8970 | 0.0000 |
| IA | 3.7570 | 1.2730 | 2.9510 | 0.0040 |
| LAIB | -1.5300 | 0.1040 | -14.6790 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9630 | Studentized Breusch-Pagan test | |
| F-value | 618.9370 | p-value | 0.3000 |
| N | 95 | | |

**2015**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1302000 | 776400 | 1.6780 | 0.0970 |
| ABPI | 1.2680 | 0.1130 | 11.2200 | 0.0000 |
| PPE | 17.4400 | 0.5820 | 29.9700 | 0.0000 |
| IA | 3.1830 | 1.3180 | 2.4150 | 0.0180 |
| LAIB | -1.3540 | 0.1220 | -11.0500 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9420 | Studentized Breusch-Pagan test | |
| F-value | 421.9720 | p-value | 0.0300 |
| N | 104 | | |

**2016**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1448000 | 678500 | 2.1340 | 0.0350 |
| ABPI | 1.4010 | 0.0970 | 14.5100 | 0.0000 |
| PPE | 12.3000 | 0.4760 | 25.8500 | 0.0000 |
| IA | 4.7910 | 1.4530 | 3.2970 | 0.0010 |
| LAIB | -1.4700 | 0.1050 | -13.9400 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9430 | Studentized Breusch-Pagan test | |
| F-value | 473.7890 | p-value | 0.0100 |
| N | 115 | | |

**2017**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 588531 | 550668 | 1.0690 | 0.2870 |
| ABPI | 2.0380 | 0.0860 | 23.7090 | 0.0000 |
| PPE | 15.8480 | 0.4110 | 38.5160 | 0.0000 |
| IA | 6.3100 | 1.2570 | 5.0190 | 0.0000 |
| LAIB | -2.1760 | 0.0940 | -23.1080 | 0.0000 |

| | | | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9700 | Studentized Breusch-Pagan test | |
| F-value | 1029.9680 | p-value | 0.2000 |
| N | 128 | | |

**2018**

| | Estimate | Std. Error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1166000 | 762400 | 1.5290 | 0.1290 |
| ABPI | 1.5240 | 0.1200 | 12.6500 | 0.0000 |
| PPE | 12.9800 | 0.5270 | 24.6000 | 0.0000 |
| IA | 6.0270 | 1.6110 | 3.7420 | 0.0000 |
| LAIB | -1.6230 | 0.1330 | -12.2400 | 0.0000 |

| | | Studentized Breusch-Pagan test | |
|---|---|---|---|
| Adjusted $R^2$ | 0.9180 | | |
| F-value | 388.2440 | p-value | 0.0300 |
| N | 139 | | |