Aalto University
School of Business

The Effect of the Amount of Research and Development Spending on the Growth and Profitability of a Firm

An Empirical Study on US-based Publicly Traded Companies

Master's Thesis
Teemu Leskinen
Aalto University School of Business
Accounting
Fall 2018

Aalto University
School of Business

Aalto University, P.O. BOX 11000, 00076 AALTO
www.aalto.fi

Abstract of master's thesis

Author Teemu Leskinen

Title of thesis The Effect of the Amount of Research and Development on the Growth and Profitability of a Firm: An Empirical Study on US-Based Publicly Traded Companies

Degree Master's degree

Degree programme Accounting

Thesis advisor(s) Emma-Riikka Myllymäki

Year of approval 2018 **Number of pages** 69 **Language** English

Abstract

This thesis studies how the amount of research and development (R&D) spending effects a company's growth and profitability in US-based publicly traded companies. The advancement of technology has increased the importance and amount of R&D even further than before. However, in spite of this to the researcher's knowledge there have not been many studies with data from the 21st century. This work will present literature regarding the treatment of R&D expenses in financial statements, previous research regarding the treatment of R&D in financial statements, as well as its' effect on firm growth and profitability. Finally a correlation analysis and multiple linear regression analyses will be conduct to find out the effects of R&D on growth and profitability.

The treatment of R&D in discussed with regards to the US GAAP, which contains the accounting principles that US-based companies have to abide to. Additionally, how R&D is treated in the IFRS-standards will be explained. Previous research regarding the treatment of R&D in financial statements is examined, as well as research concerning how R&D expenditure affects a firm's growth and profitability. There is no unanimity on whether or not R&D spending should be capitalized or expenses. On the other hand, there is a clear consensus when it comes to the effect R&D has on the growth of a firm, the effect is positive. However, with regards to profitability, the views are not as identical, but the majority of the research does indicate that R&D spending should increase the profitability of a firm.

The data that is used in the study comes from the Compustat-database. The final sample includes 675 companies and 8100 firm-year observations from 2005-2016.

The growth of a firm is measured by revenue growth, while the profitability of a firm is measured using the earnings before interest and taxes -percentage (EBIT-%) and the return on assets (ROA). The measure for R&D spending is R&D-intensity, which is measured using the R&D spending of firms scaled to their revenue or total assets. The results from our analyses regarding firm growth indicate that higher R&D-intensity increases a company's revenue growth. These results are congruent with the results from previous literature. However, the results concerning firm profitability are contrary to previous research. The results in this thesis indicate that higher R&D-intensity has a negative effect on profitability.

Keywords Research and Development , firm growth, profitability

Aalto-yliopisto
Kauppakorkeakoulu

Aalto-yliopisto, PL 11000, 00076 AALTO
www.aalto.fi

Maisterintutkinnon tutkielman tiivistelmä

Tekijä Teemu Leskinen

Työn nimi Tutkimus- ja kehittämismenojen määrän vaikutus yrityksen kasvuun ja kannattavuuteen Yhdysvaltalaisissa pörssiyrityksissä

Tutkinto Kauppatieteiden maisterin tutkinto

Koulutusohjelma Laskentatoimi

Työn ohjaaja(t) Emma-Riikka Myllymäki

Hyväksymisvuosi 2018 **Sivumäärä** 69 **Kieli** Englanti

Tiivistelmä

Työni käsittelee tutkimus- ja kehittämismenojen määrän (T&K-menojen) vaikutusta yrityksen kasvuun ja kannattavuuteen pörssiyrityksissä Yhdysvalloissa. Teknologian kehittyminen on kasvattanut tutkimuksen ja kehittämisen vaikutusta ja tärkeyttä entisestään. Tästä huolimatta on hyvin vähän kattavaa tutkimusta 2000-luvulta aiheeseen liittyen. Työssä käsitellään aikaisempaa kirjallisuutta liittyen T&K-menojen käsittelyyn ja vaikutukseen yrityksissä ja lopuksi suoritetaan empiirinen osuus, mikä sisältää korrelaatioanalyysin ja regressioanalyysin.

Työssä käydään läpi tämänhetkistä T&K-menojen tilinpäätöskäytäntöä USA:ssa, sekä esitellään IFRS-standardin T&K-menojen käsittely, jota suurin osa muusta maailmasta noudattaa. Yhdysvaltaiset yritykset noudattavat US GAAP:n mukaisia tilinpäätösstandardeja, kun muualla noudatetaan pääosin IFRS-standardeja.

Aikaisempaa tutkimusta esitellään liittyen sekä T&K-menojen kohteluun tilinpäätöksessä, että T&K-menojen vaikutuksesta yrityksen kasvuun ja kannattavuuteen. Siitä pitäisikö T&K-menot kirjata kuluiksi vai antaa aktivoida taseeseen ei ole aikaisemmassa tutkimuksessa yksimielisyyttä, vaan kyse on relevanssin ja luotettavuuden vaihtokaupasta. Yrityksen kasvuun liittyen aikaisempi tutkimus antaa konsensuksen siitä, että T&K-menoilla on positiivinen vaikutus. Kannattavuudesta tulokset eivät ole yhtä yksiselitteisiä, mutta suurin osa puoltaa, että kannattavuus kasvaa T&K-menojen kasvaessa.

Tutkimusdata on Compustat-tietokannasta. Lopullinen datamäärä on 8160 yrityshavaintoa 680:stä yrityksestä vuosilta 2005-2016.

Yrityksen kasvua mitataan liikevaihdon kasvun avulla ja kannattavuutta liiketulos-prosentilla ja pääoman tuottoasteella (EBIT-% ja ROA). T&K-menojen mittarin toimii T&K-intensiteetti, jossa T&K-menot on suhteutettu joko liikevaihtoon tai pääomaan. Korrelaatio- ja regressioanalyysin tulokset ovat yrityksen kasvun osalta samassa linjassa aikaisemman tutkimuksen kanssa. Tuloksissa T&K menojen lisääminen parantaa yrityksen liikevaihdon kasvua. Kuitenkin tulokset kannattavuudesta ovat hyvin ristiriitaisia edellisen tutkimusten kanssa. Saatujen tulosten mukaan yritysten kannattavuus heikkenee mitä suurempi on yrityksen T&K-intensiteetti.

Avainsanat Tutkimus- ja kehittämismenot, yrityksen kasvu, kannattavuus

Table of Contents

List of Tables

List of Figures

Glossary

FASB	= Financial Accounting Standards Board
IAS	= International Accounting Standards
IFRS	= International Financial Reporting Standards
OECD	= Organization for Economic Co-operation and Development
EBIT-%	= Earnings before interest and taxes -percentage
ROA	= Return of Assets
SEC	= Securities and Exchange Commission
SFAS	= Statement of Financial Accounting Standards

1 Introduction

1.1 Background

The Cobb-Douglas production function in its simplest form defines production as a function of productivity (index of production), labor inputs and capital input (Cobb & Douglas, 1928). Technological advancements contribute to productivity, thus increasing the output or production, meaning that successful research and development (henceforth R&D) increases productivity, economic growth and social welfare (Lev & Sougiannis, 1996). Furthermore, the Cobb-Douglas function is applicable from a specific product all the way to the global economic output. While labor and capital can be limited under certain conditions, for instance the amount of people in a country or the amount of resources available, technology can always advance further through R&D. Once the resources on earth run out, the only option for increasing economic value and social welfare will be through R&D and advances in technology. During the last 200 years, the United States of America (henceforth US) have invested more and more in R&D and technological advancement. Furthermore, through these investments, the social and economic welfare in the US has grown exponentially over the past 200 years (Corrado, Hulten & Sichel, 2006).

The US has been a frontrunner in R&D investments. Moreover, R&D expenditures are and have been an important part of the US economy, and are an essential factor for the growth of the US economy (Statement of Financial Accounting Standards (henceforth SFAS) No. 2.17). In 1996, the US had the fifth highest investment in R&D as a percentage of GDP in the world. However, by 2015, the US had dropped to ninth in the world. Yet, the R&D expenditure as a percentage of GDP has still increased from 2,44% to 2,79% (The World Bank, Databank, United States). While these corresponding figures for the EU, for instance are 1,58% in 1996 and 1,96% in 2015(OECD, Data, accessed 29.11.2017), and for the entire world they are 1,97% and 2,23%. In the US alone, over 500 billion dollars was spent on R&D, indicating the importance it holds for future economic opportunities and benefits. However, it is important to note that the before mentioned spending incorporates both R&D investments in all private entities as well as R&D investments done by any public entities. (The World Bank, Databank, Research and development expenditure (% of GDP))

A lot of the existing research on R&D expenditures focuses on the effect of R&D on share prices, market returns and market value (Chambers, Jennings & Thompson II, 2002). The different findings regarding the relationship between R&D spending, share prices and market values have fueled the conversation on how R&D costs should be treated in financial accounting and financial statements (Sougiannis 1994). There has also been research concerning the effect of R&D spending on growth, such as Del Monte & Papagni's (2003) or Lee & Shim's (1995) research papers, where both studies found a positive correlation between R&D spending and the growth of a firm. Furthermore, most of the more recent research has also found a positive association between R&D and market returns. For instance, Lev & Sougiannis (1996) found that R&D investments are associated with excess returns. While Chan, Martin & Kensinger (1990) found that in high-tech industries higher levels of R&D are associated with abnormal returns. As most of the recent studies are inclined towards R&D having a positive impact on the future profitability and growth of a firm, this will be the direction pursued in this study as well.

1.2 The Purpose and Limitations of the Study

The purpose of this study is to examine the connection between the amount of R&D spending and the growth and profitability of US-based publicly traded companies. The investigated variables are the growth of revenue as a percentage of the previous year's revenue, the return on assets (ROA), and the earnings before interest and taxes -percentage (EBIT-%). The data used in the study will be from 2005-2016 and the data will be collected from Wharton Research Data Services' (WRDS) COMPUSTAT Capital IQ –database. The data consists of US-based publicly traded companies, and contains 8160 firm-year observations. Using the data, some descriptive statistics will be presented, a correlation analysis will be performed, and multiple linear regression analyses using the ordinary least squared (OLS) method will be conducted.

While the effect of R&D costs on future economic benefits has been largely examined, most of the data used in previous studies has come from before the turn of the millennium. Furthermore, as mentioned previously, the studies focus has often been to examine the effect on share prices, returns and market value. Additionally, examining the effect of the amount of R&D on the growth of revenue or on profitability measures, such as EBIT-% or ROA, have not been as popular, and there have been no studies in the US with recent data according to the researcher's knowledge. Not to mention that most of the research focuses on the effect of R&D on the following year or the next couple of years. This study, on the other hand, will attempt to examine the next nine years after the R&D investment.

The US is an attractive ground for research as there is plenty of data available. Moreover, as mentioned previously the US is one of the frontrunners in R&D investments globally and has been for a long time. Another reason for choosing the US as the research ground is that the US follows its own generally accepted accounting principles (US GAAP), which makes the results unique. This is in comparison to most of the western world, which follows the International Financial Reporting Standards (IFRS), for example, all publicly traded companies in the EU need to adhere to the IFRS (International accounting standards, Regulation (EC) No 1606/2002).

The major limitations of the study are that it only compasses US –based publicly traded companies. The data also only consists of companies that have done R&D research and excludes companies with no R&D investments, as we are examining how the amount of R&D investments affects growth and profitability. Furthermore, the sample excludes some companies due to missing firm-year observations, etc. In addition, since the US follows their own accounting standards, the US GAAP, it poses an obstacle to the generalization of the results of the study. Additionally, the business environment is different to most of the world and results obtained in this study will most likely not be generalizable to most countries around the world.

1.3 Summary of the Results

The results in the study indicate that a higher amount of R&D spending does in fact have a positive effect on revenue growth. This followed the expectations brought forth from previous research. This was demonstrated through correlation analysis and the multiple linear regression analyses. Regarding profitability, the evidence from our different analyses actually indicate that higher amounts of R&D spending have an adverse effect on the profitability of the firm. Whether in the correlation analysis or the regression analyses, the results illustrate a negative relationship between higher R&D spending and EBIT-% or ROA.

1.4 The Structure

Following the introduction, section 2 will cover the treatment of R&D costs in financial statements, with a focus on the US GAAP regarding R&D costs all the while briefly going through the IFRS conduct concerning R&D costs. The third section covers previous research of the treatment of R&D costs, as well as research regarding the effect of R&D on growth and profitability. Section 4 introduces the data and the research methodology used in the study. The results and analysis of the results are examined in section 5. Finally, the research paper concludes in section 6, which summarizes the study's conclusions and the most important results.

2 The Treatment of Research and Development Costs in Financial Statements

2.1 Research and Development Costs according to US GAAP

The US follows their own generally accepted accounting principles (US GAAP). The Financial Accounting Standards Board (FASB) publishes the US GAAP and the Securities and Exchange Commission (SEC) organizes the FASB. (FASB, accessed 27.11.2017) FASB is the entity that has released the SFAS No. 2, released in 1974, which establishes the standard for how R&D is treated in financial accounting and reporting. The statement outlines, what is classified as R&D, what cost elements are defined as R&D activities, the accounting procedure for R&D expenditure and what financial statement disclosures are related to R&D expenditure. (SFAS 2.1) However, there exists a separate statement for the costs from computer software development meant for sale, to be leased or marketed otherwise (SFAS 86).

2.1.1 The Definition of Research and Development

The definition of R&D in the SFAS No. 2 was developed by examining the definition for R&D done by the National Science Foundation (NSF) (SFAS 2.25). Research is defined as the search for new knowledge with the purpose of creating a new product, process or possibly improve an existing product or process (SFAS 2.8a). While development is defined as the process of applying findings from research to significantly improve an existing product or process or a completely new product or process. It does not matter whether the product is for the own use of the entity or if it is meant for sale. This includes, for instance, all kinds of design, testing or construction of product alternatives or prototypes. However, market research and all kinds of market testing are not regarded as development. (SFAS 2.8b) Furthermore, it is important to note that R&D that is performed for other entities under a contractual agreement falls outside of the scope of SFAS No. 2 and is considered a part of accounting for contracts (SFAS 2.2).

2.1.2 Cost Elements of Research and Development

The elements of cost for R&D are divided into five categories:

a) Materials, equipment, and facilities

In case that the materials, equipment or facilities are specifically purchased or obtained for a distinct R&D project and do not have any alternative uses in the future, they must be expensed when the costs are incurred. However, if the materials, equipment or facilities used in an R&D project are acquired or are already present and have a future alternative use, they are capitalized upon acquisition or construction. The materials are only incurred as costs when they are consumed and the depreciation of the used facilities or equipment is incurred as R&D costs. (SFAS 2.11a)

b) Personnel

All the costs of personnel working or participating in the R&D activities is included in the R&D costs. This includes salaries, wages and other personnel costs. (SFAS 2.11b)

c) Intangibles purchased from others

The treatment of intangibles is similar to that of materials, equipment and facilities. If the purchased intangible has no alternative future use, the intangible counts as a R&D cost the moment that the cost is incurred (purchased). However, if the intangible has other future uses then the amortization of the intangible asset that is being used in the R&D ventures is an R&D expense. (SFAS 2.11c)

d) Contract services

In line with an entity's own contractually performed R&D, the contractual R&D performed by others is a R&D cost. (SFAS 2.11d)

f) Indirect costs

Indirect costs are allocated to R&D in a reasonable manner. Only clearly evident general and administrative costs are included in R&D costs. General and administrative costs that are not related are not included. (SFAS 2.11f)

2.1.3 Accounting for Research and Development Costs

All the aforementioned R&D costs should be immediately expensed (SFAS 2.12). The argument for expensing the R&D costs is based on the uncertainty of future benefits from R&D projects. The probability of failure for new projects and developing projects is extremely high. This probability of failure naturally diminishes as the project moves along, but even projects that have passed the R&D phase still have a risk of failure. (SFAS 2.39, 2.40)

There has to be an expected future benefit from an economic resource, defined as a "scarce resources for carrying on economic activity" (SFAS 2.42), and with R&D this future benefit is unreliable and it is likely that the potential benefit will not be realized (SFAS 2.42). Another important factor of a project to be an asset is its measurability (SFAS 2.43). For an asset to be measurable, the resource's benefits must be identifiable and the amount must be calculable (SFAS 2.44). Because of the previously mentioned uncertainty of future benefits, it is hard to measure a R&D venture's future benefit. Even though there can be certainty of the success, the amount of benefits will be hard to measure. (SFAS 2.45)

There are three prevalent principles, when costs could be capitalized. These are: "*associating cause and effect, systematic and rational allocation, and immediate recognition*" (SFAS 2.48). Associating cause and effect refers to being able to connect a cost to a certain revenue. Systematic and rational allocation implies that if a cost can provide a benefit over several periods in a rational and systematic manner then it can be capitalized. If a cost cannot provide recognizable future benefits in this period or subsequent periods, it cannot be immediately recognized. R&D projects fulfill none of the criterion, as they are considered uncertain to provide benefits. (SFAS 2.48, 2.49)

Due to the lack of predictability of future benefits, the capitalization of R&D projects does not give any useful information. Simply put, the information that is useful for financial statement users can be divided into two basic elements; expected returns and risk, as in the variability of the returns. According to selected analysts and bankers, the connection between future earnings and R&D costs is so uncertain that capitalizing it can provide no useful information to financial statement users. Consequently, capitalizing the R&D cost would make it harder to predict the return and even increase the variability of said return. (SFAS 2.50)

The only exception that can be made under certain conditions is the R&D costs of software to be sold, leased or otherwise marketed. However, the software has to be technically feasible, meaning that either the product design or detail program design have been completed. Furthermore, the company needs to have the necessary skills, hardware and software to produce the product (SFAS 86.4a(1)) or the detail program design is consistent with the product design and it has been confirmed by documenting and tracing (SFAS 86.4a(2)). Another exception is if the software has a working model (SFAS 86.4b).

2.2 Research and Development Costs according to IFRS

The International Accounting Standards Board sets the IFRS Standards (IFRS, "Who we are", accessed 12.3.2018). Currently, the IFRS standard is used in 166 jurisdictions, of which IFRS standards are required "*for all or most accountable entities in their capital markets*" in 144 of the jurisdictions. The remaining jurisdictions allow or follow the IFRS standards to different extents (IFRS, "Who uses IFRS Standards?", accessed 12.3.2018).

The International Accounting Standard 38 (IAS 38) contains the standards set for treatment of Intangible Assets in accounting (IAS 38.1), including research and development expenses. An asset can be defined as an intangible asset if it fulfills three criteria. Firstly, needs to be identifiable, meaning that it can be separated from the entity, "*sold, transferred, licensed, rented or exchanged, either individually or together with a related contract*" or the asset arises from legal rights, e. g. contractual rights (IAS 38.11, 38.12). Secondly, it needs to be controllable by an entity. Control of an asset is defined by the entity being in control of the future benefits of the asset, as well as being able to restrict others from said benefits. Usually legal rights achieve this; however, it is not a necessity to be through legal rights (IAS 38.13). Finally, the entity has to bring future economic benefit. This can be in the form of sales from products, cost savings, etc. (IAS 38.17). The asset is recognized as an intangible asset, if it can fulfill the recognition criteria, which include that the economic benefits from the asset are expected to flow to the holding entity and that the costs regarding the entity can be reliably measured. (IAS 38.21).

Furthermore, the future economic benefit of the asset and the economic conditions that exist during the useful life of the asset should be measured and estimated to the best of the management's abilities (IAS 38.22). Additionally, according to IAS 38.24: *"An intangible asset shall be measured initially at cost"*.

Research and development activities are included in IAS 38. This is due to them being directed towards the development of technical or scientific knowledge, and possibly applying said knowledge to a plan or design to create or improve products, processes, etc. Therefore, they do not have a physical substance, even though R&D may create something with a physical substance, for example, a prototype. (IAS 38.5, IAS 38.8)

The biggest difficulty in the recognition of internally generated assets through R&D, lies in whether the asset can generate the expected future benefits and whether the cost of the asset can be determined reliably (IAS 38.51). R&D is always divided into two distinct phases, the research phase and the development phase (IAS 38.52). The research phase can be defined as the search for new knowledge, or its application, or the search for or evaluating alternative materials, processes, etc., for example (IAS 38.56). While the development phase is thought of as the design, construction and testing of prototypes, or pilot plants and choosing alternative materials, processes, etc. (IAS 38.59). If the entity cannot be divided into these two phases, then the expenses generated by the entity will always be treated as if they were incurred in the research phase (IAS 38.53). Furthermore, all expenses incurred in the research phase shall be expensed, and no entity can be thought of as an intangible asset in the research phase (IAS 38.54), as it is not possible to determine whether said entity can generate probable future economic benefit (IAS 38.55). Intangible assets in the development phase shall be recognized if they meet the aforementioned criteria of intangible assets and there is an intention and possibility of finishing it for use or sale (IAS 38.57).

Only costs that can be directly attributed to an intangible asset shall be considered in its' valuation (IAS 38.65, IAS 38.66). All other costs should be expensed (IAS38.68), and if an expenditure has been recognized as an expense it cannot be considered as part of the cost of the intangible asset in the future (IAS 38.71).

There are two different accounting policies that can be used regarding intangible assets; the cost model or the revaluation model (IAS 38.72). The cost model values intangible assets at cost after deducting any amortizations or impairment losses (IAS 38.74). On the other hand, the revaluation model values intangible assets at their fair value at the date of the revaluation less any amortizations or impairment losses. Revaluation shall be conducted as often as necessary so that at the end of the reporting period the valuation does not differ materially from the fair value of the asset. The fair value is determined with reference to an active market. (IAS 38.75) In case that the revaluation model cannot be used, the cost model is to be used (IAS 38.81), and if the fair value of an asset can no longer be determined through an active market then the carrying amount is the last revalued amount (IAS 38.82). If the carrying amount of an asset increases, it is recognized in comprehensive income and an increase in equity (IAS 38.85), while a decrease is recognized in profit or loss (IAS 38.86). However, if there has been an increase before a decrease, the decrease is recognized in the comprehensive income and equity until the increase has been negated. The same holds true for when there has been a decrease before an increase, then the increase is first recognized in profits or losses (IAS 38.85, IAS 38.86).

The useful life of an entity has to be determined to be finite or infinite. A finite useful life means that the length of use or the number of production units or similar determines the useful life. While for an infinite useful life there is no limit to the period of time during, which the asset can generate economic benefit for the entity. (IAS 38.88) If an asset has a finite useful life, the depreciation shall be allocated systematically over its useful life. The amortization of the asset shall begin at the date when the asset is ready for use and the method should reflect the pattern of the future economic benefits from the asset (IAS 38.97). The amortization method shall be evaluated at each financial year-end and changed according to its' expected pattern of economic benefit (IAS 38.104). The residual value of finite assets shall be zero, unless a commitment has been made by a third party for purchase or there is a market at the end of its' useful life, where a residual value can be determined (IAS 38.100). While assets with infinite useful lives shall not be amortized (IAS 38.107). However, each asset with infinite useful lives shall be reviewed during each financial period and be assessed whether it still has an infinite useful life (IAS 38.109).

There are multiple disclosures regarding intangible assets. Firstly, whether the asset's useful life is finite or infinite, and in the case of the useful life being finite, the amortization rates and method used must be disclosed. Secondly, the carrying amount and accumulated amortization should be disclosed. Finally, the line items where any amortization of an intangible asset is included and a reconciliation of the carrying amount at the beginning and end of a period (IAS 38.118). In case of a revalued asset, the date of revaluation, the carrying amount, the carrying amount in case of the use of cost model and the amount of the revaluation surplus related to the intangible asset at the beginning and end of the period (IAS 38.124). Regarding R&D expenditure the entity has to disclose the expenditure amounts that are recognized as expenses during the financial period (IAS 38.126).

2.3 Differences between IFRS and US GAAP

The IFRS allows development phase costs to be capitalized under certain conditions. This can be considered the most common approach currently, which is evident by the fact that most jurisdictions in the world follow the IFRS standard (IFRS, "Who uses IFRS Standards?", accessed 12.3.2018). However, even if the development costs are allowed to be capitalized, the conditions for capitalization have to be met (IAS 38). The US, on the other hand, does not allow the capitalization of R&D costs, and they should be expensed instead. This can be considered the more reliable approach (SFAS 2), compared to the IFRS standard. The US is only one of the few jurisdictions that still does not generally allow for the capitalization of R&D costs (Powell, 2003). The exception to this are the previously mentioned R&D costs of software that is internally developed, but even then it is only under certain circumstances (SFAS 86).

3 Previous Research Regarding Research and Development Costs

3.1 The Treatment of Research and Development Costs in Financial Accounting

Kothari, Laguerre and Leone (2002) research the uncertainty or variability of future benefits from R&D investments, when compared to capital expenditures. The study hopes to shed some light on the debate on whether R&D expenditures should be expensed or capitalized. Kothari et al (2002) find that R&D expenditures have a significantly higher variability and uncertainty, when compared to capital expenditures. In fact, the difference in uncertainty is up to three times higher for R&D investments in comparison to capital investments. It is however, important to point out that Kothari et al (2002) do not form an opinion on whether R&D expenditure should be capitalized or expensed in financial reporting. As their research only emphasizes that benefits from R&D expenditures are more uncertain than from capital expenditures. The research focus is on the reliability part in the reliability-relevance trade-off. It could still be argued that the relevance of capitalized R&D expenditures makes it worthwhile to have the expenses on the balance sheet as capital.

In their research Lev & Sougiannis (1996) adjusted the reported earnings and book values of firms following US GAAP (data from 1975 to 1991) to reflect values, if R&D expenditures were capitalized instead of expensed. With these adjusted earnings and book values, they found a strong association between R&D capitalization and stock prices and stock returns. All the while contradicting the FASB statement No. 2, which says that there is no demonstrated relationship between R&D costs and future benefits, such as sales or earnings, for instance.

According to Chan, Lakonishok & Sougiannis (2001) expensing large R&D investments instead of capitalizing the R&D can possibly create considerable mispricing of stocks. Chan et al (2001) found that in their sample of all domestic stocks traded on NYSE, NASDAQ and AMEX there are considerable differences in price-earnings ratios as well as book-to-price ratios, when R&D spending is expensed or capitalized. This means that if investors do not consider these factors there will be potential for extreme misevaluation of stock prices. On the other hand, Chan et al (2001) did not find an association between R&D spending and increased stock returns. Yet, there was evidence, where R&D played a role in excess returns and this was for companies with high intensity R&D when scaled to market value of equity. This means that companies with low market value, indicating poor past performance, that continued to spend on R&D experience excess returns in the amount of 6,12 percent on average over the following three years. Nonetheless Chan et al (2001) find proof that higher R&D intensity correlates with higher volatility, concluding that even though market prices integrate the future benefits from R&D, there may be real costs to investors in the form of increased volatility, due to the lack of accounting information. This suggests that allowing for capitalization of R&D expenditures could be well advised.

Amir, Guan & Livne (2007) find that R&D investments are not necessarily riskier than capital investments. In their research paper, they find that R&D spending only affects the variability of operating income more than physical investments in high-intensity R&D industries. This means that there is only a fundamental difference in risk in high-intensive R&D industries. Whereas in highly physical capital-intensive industries there is no difference in the risk between R&D investments and physical capital investments. Amir et al (2007) indicate that the US GAAP, as it stands may be too conservative in its' policies regarding R&D capitalization. They voice support to having certain situations where capitalization of R&D expenditures should be allowed for more relevant accounting information, as can be deduced from Chan et al (2001) or as is the case with the IFRS.

SFAS No. 86 allows software companies to capitalize their software development costs. Aboody & Lev (1998) examine this relationship and they find evidence that capitalization is associated with earnings. In addition, they found that completely expensed software costs caused a delayed reaction in stock returns. This would indicate that capitalization of software development would be the correct way to go. However, there is also a connection between the intensity of software capitalization and analysts' forecasting errors related to earnings. This result is in line with Amir et al (2007) findings, where they find that capitalization of R&D expenditures can be relevant in some situations. There is even evidence that expensing R&D or other intangible assets can result in higher ROE or ROA figures in companies with good profitability and decreasing investments in internally developed R&D. Moreover, Aboody &

Lev (1998) point out that when generalizing this research in software to all R&D it can only be applied to the development component of R&D expenditures. Even so, as was the case in Kothari et al's (2002) there are questions about the reliability of the information when intangible assets from R&D or software development are immediately expensed, as the predictability of earnings is weakened and the quality of forecasts suffers.

According to Hoegh-Krohn and Knivsflå (2000) the value-relevance of financial statements has declined, they emphasize this point by outlining other research, which has had similar results (eg. Lev & Zarowin (1999)). They suggest that this could be changed by allowing for more capitalization of R&D expenses. However, they propose that it should be done by conditionally giving the possibility of reversing expensed R&D expenditures and capitalizing them, once the R&D costs has created a recognizable asset that can produce future economic benefits. This reversion should be done in the period, when the benefits of the asset will come to fruition. Reversing the expense as capital would signal that the asset will create earnings and thus increase the earnings, whereas if the R&D costs are expenses it would decrease earnings and signal that it at least for now will not create economic benefit.

Oswald and Zarowin (2007) examine the relationship between capitalization of R&D expenditures and the stock price information it provides, when compared to expensed R&D, in 201 firms for 1002 firm-year observations in the UK during 1991-1999. They have defined the informativeness of stock prices as the "amount of information about future earnings that is reflected in current period stock returns" (Oswald & Zarowin, 2007, p.721). In a *ceteris paribus* environment the results indicated that capitalized R&D expenditures held more information on future earnings. However, Oswald & Zarowin (2007) underline that the results should be taken with caution as their sample was limited and the time-frame during which the research was done was limited.

3.2 Effect of Research and Development Expenditures on Growth

Lee & Shim (1995) find that there is a significant and positive relation between R&D investment and growth of a firm in high-tech companies in the US and Japan. As a measure of for growth of a firm, the growth of sales was used. The regression performed by Lee & Shim

(1995) showed that R&D has a significant effect on the growth of companies on the 5 % significance level. With the US having a slightly higher coefficient when compared to Japan. In their research, they also believe that R&D investments should be considered long-term investments. In fact, it could even yield adverse effects on short-term profitability (Erickson and Jacobson, 1992).

Research conducted on 500 Italian firms with data from 1989 to 1997 by Del Monte & Papagni (2003) discovered a statistically significant connection between R&D expenditure and the growth of a firm. As a measure of growth, Del Monte & Papagni (2003) used the growth rate of sales and the growth rate of employment for companies. The results were that sales grew on average by 56,4 percent for companies performing R&D, while the corresponding number was 57,4 percent for non-R&D firms. The difference in these percentages are relatively small. However, when comparing the growth rates of employment, the difference is far larger, as companies conducting R&D had a growth rate of 17,8 percent, while non-R&D companies had only 10,4 percent. The relative growth of R&D firms is more than 1,5 times that of non-R&D companies for employment growth.

R&D is found to have a positive effect on the growth of revenues in Chen, Cheng & Hwang's (2005) research paper. The paper's main focus is on studying intellectual capital and the effect of R&D and advertising expenditures on firm profitability and growth. The study encloses data from publicly traded Taiwanese companies between 1992-2002 and contains 4254 firm-year observations. The regressions were run with all variables depicting the same year, as well as having the dependent variables lag by one to three years. In their study they find that R&D is positively associated with the growth of revenue and that the relationship is significant on the five percent level. However, by including R&D and advertising expenses into their previous model only improved the explanatory power marginally. The connection between revenue growth and R&D was also perceived, when revenue growth was lagged by one, two, or three years. Chen et al (2005) conclude that intellectual capital efficiency and R&D can be considered indicators of a firm's financial performance.

Just as Lee & Shim (1995) found that high-technology firms in at least the US and Japanese sectors benefit from high R&D spending in terms with growth, Garcia-Manjon & Romero-

Merino (2012) find that high technology companies in Europe benefit from R&D investments in terms of revenue growth. Garcia-Manjon & Romero-Marino (2012) use a sample of 754 firms from 18 European countries during the 2003-2007 time-period to estimate the effect of R&D on company growth. They found that for high-technology industries and knowledge intensive services there was a positive correlation between firm growth and R&D, even when there is a recession investment in R&D seems to bring benefits for high-tech firms. However, for low-technology industries and less knowledge intensive services no visible benefit was found from investing in R&D.

Morbey & Reithner (1990) study the relationship between R&D spending and sales as well as R&D spending per employee. They discover a strong direct relationship between R&D intensity, calculated as R&D spending per sales, and growth in sales. Based on this study and Morbey's (1988) previous study bigger and smaller companies, meaning companies with more and less than $500 million in sales per year at the time of the studies (1976-1987), higher R&D intensity translates to more growth in sales. However, Morbey & Reithner (1990) do not find a connection between future profit margins and R&D intensity. On the other hand, there is a positive relationship between R&D expenditures and the future productivity of the company per employee. Meaning that due to the higher productivity, there is an association between R&D spending per employee and future profit margins.

3.3 Effect of Research and Development Expenditures on Profitability

The previously mentioned research of Lev & Sougiannis (1996) found that the R&D capital is not reflected in stock prices or stock returns means that there is either systematic mispricing or that the excess returns or abnormal returns[1] are due to an added risk associated with R&D investments. Furthermore, they found that the average earnings are understated by 20,55 percent, with industry average between 9,7 percent to 26,8 percent. While the reported equity was understated on average by 22,2 percent and with a range from 12,3 percent to 24,6 percent.

[1] i. e. the underlying asset's actual return has been higher than the market return, which in turn would indicate that the underlying asset has had an increased in profitability or the asset is expected to have higher earnings in the future

This research supports the idea that R&D investments and expenditures do in fact have an association with future company benefits and earnings.

Where Lev & Sougiannis (1996) did not find conclusive evidence regarding what is the cause of excess returns in R&D investments, Chambers et al (2002) hoped to do so. They explored what causes the associated excess returns with higher levels of R&D investments and the growth in R&D investments. In their study of all NYSE-, ASE- and NASDAQ-traded firms over the period of 1979-1998 they found that the excess returns are primarily explained by the higher associated risk of companies with higher levels of R&D investments and growth in R&D investments. Furthermore, this association is persistent for at least ten years after the R&D investments are made. Moreover, the excess returns are more volatile for firms with higher R&D investments and analysts' forecasts reflect this, as their forecasts are more volatile for firms with higher-intensity R&D than for firms with lower-intensity R&D. They find no evidence that the excess returns are due to mispricing as has been suggested in previous research.

Furthermore, Chan et al (1990) found a connection between announcements of increasing R&D investments and abnormal stock returns in U.S.-based firms between 1978 and 1985. The full data set contained 95 announcements from different industries. There were statistically significant abnormal returns during the two days after an announcement to increase R&D expenditures, which would indicate that with the announcement the profitability of the company is expected to increase. This was especially the case for firms in high tech industries that already had high R&D expenditure. Additionally, the stock value increased even, if the R&D announcement was accompanied with an announcement of decreasing earnings. This suggests that investors value R&D expenditure, and have long-term considerations for the effects of R&D, believing them to be positive, at least for high-technology companies. However, in industries with low technology the announcements of R&D increases had mainly a significantly negative impact on stock prices.

Sougiannis (1994) explores the impact of R&D expenditures on long-term earnings and the market value of equity in his research paper. He finds that in publicly traded U.S.-based companies a one-dollar increase leads to a two-dollar increase in earnings on average over a seven-year period. Likewise, a one-dollar increase in R&D will on average result in a five-dollar increase in market value over seven years. Sougiannis (1994) suggests that R&D expenditures are relevant for an average of seven years. However, for some firms the effects can last even over 10 years. This result conforms to the results obtained by Chambers et al (2002) in their research paper, where they found that company R&D investments possibly affect its profitability and earnings at least ten years into the future.

Del Monte & Papagni (2003) on the other hand did not find any relation between firm profitability and R&D. Their measure for profitability was the return on sales, and they found no evidence that would suggest that there was a positive effect by R&D on the growth rate of return on sales.

Kallunki, Laamanen & Pyykkö (2009) investigate whether technology mergers and acquisitions (M&As) can increase the effect of a firm's R&D Spending on the market value and future profitability of the firm. The study is done using US-based acquirers and includes 20,583 firm-year observations from 1,751 M&As. There results of the study indicate that when technology firms acquire other technology firms the effect of the acquirer's R&D spending enhances the stock market valuation of the firm. However, there is an inverse effect when a non-technology firm acquires a technology firm. Evidence is also found that technology firms are more successful in converting their technology M&As into increased future profitability than non-technology firms. They use 3-year and 5-year future earnings as the measure for profitability. The reasons for these results could be that the non-technology firms do not have the capability or capacity to extract the value from the R&D of the acquired technology firms.

In their research paper, Penman & Zhang (2002) study accounting conservatism and the quality of earnings. The data in their study is from NYSE and AMEX, without financial firms, from the years 1975-1997. They use diagnostic measures to study the future returns on net operating assets and stock returns. Within their study, they find a positive association between changes in research and development expenses and the future return on net operating assets.

Kotabe, Srinivasan & Aulakh (2002) study the effect of multinationality of a firm and firm performance, and R&D and marketing moderate the effects of multinationality. They perform a regression analysis using data from the US. The data consists of 49 companies from 12 different industries during a 7-year time period that ends at 1993. They measure firm performance in the study by using ROA and a ratio of sales to operating costs. They find that R&D actually has a negative effect on ROA, but a highly positive effect on sales to operating costs ratio.

3.4 The Hypotheses

The formation of the hypotheses in this study will be based on the previously mentioned literature.

The first hypothesis of this study focuses on the effect of research and development expenditures on the growth of a company's revenue. Previously mentioned studies, such as Lee and Shim (1995), Del Monte and Papagni (2003), Morbey and Reithner (1990), García-Manjón anf Romero-Merino (2012), all found some level of positive correlation between a company's revenue or sales growth and R&D expenditure or intensity. Therefore, our first hypothesis will be:

Hypothesis 1 (H_1):

There is a positive correlation between the amount of a company's R&D expenditure and a company's growth of revenue.

The second hypothesis in this study will focus on the connection between a firm's profitability and its R&D spending. As suggested by for instance, Sougiannis (1994), or Del Monte & Papagni (2003), the R&D intensity of a company has a positive effect on its earnings. Thus, our second hypothesis will be:

Hypothesis 2 (H_2)

There is a positive correlation between the amount of a company's R&D expenditure and a company's profitability.

4 Data and Research Methodology

The purpose of this study is to find out the effect of the amount of R&D expenditure on the growth and profitability of a firm. The tools to find this connection will be a correlation analysis and multiple linear regression analyses. The growth will be measured as the increase in revenue, and we will measure profitability using the earnings before interest and taxes -percentage (EBIT-%) and return on assets (ROA), these will be the dependent variables in our multiple regression model. Moreover, we will take the averages of these for three different time-periods, 3, 5, and 9 years. In the following subsections, we will introduce the data, the different variables and the regression model as a whole.

4.1 The Data

All the data for this study is collected from the Compustat Capital IQ –database run by Wharton Research Data Services (WRDS). The data will consist of publicly traded companies based in the US during the years 2005-2016. All US-based companies are required to follow the US GAAP, and therefore the SFAS 2 standard.

The research and development data, as well as the data for the control variables in the regression model, will be from the years 2005 - 2007. Whereas, the data needed for the dependent variables are collected from 2008-2016, with 2016 being the most recent data available. Only companies that have been publicly traded through the entire 12-year period are included in the study. Furthermore, only companies that have engaged in R&D activities every year during the entire research period are taken into account. This was done, because the purpose of this paper is to study the effect of the amount of R&D spending on a company's future revenue growth and profitability.

The sample also excludes companies that have relevant data missing during any year for any and all of the relevant variables. Additionally, all banks and financial institutions were removed from the data, due to their unique income and financial structures (Fama & French, 1993). Finally, outliers were removed from the sample. This was done by excluding the lowest and highest percentile for each of the independent and dependent variables. This was done in order to prevent extreme outliers from affecting the multiple linear regressions in an undue fashion. The final amount of companies included in the sample is 680 companies and 8160 firm-year observations.

In Table 1 the sample is divided into technology firms and non-technology firms and further divided by industry. A more thorough division by industry can be found in Appendix A.

Table 1. Data sample divided by SIC-codes

Industry	**First two digits of SIC-codes**	**Number of Firms**	**Percentage of data**
CHEMICALS AND ALLIED PRODUCTS	28	108	15,88%
INDUSTRIAL AND COMMERCIAL MACHINERY AND COMPUTER EQUIPMENT	35	87	12,79%
ELECTRONIC AND OTHER ELECTRICAL EQUIPMENT AND COMPONENTS, EXCEPT COMPUTER	36	118	17,35%
TRANSPORTATION EQUIPMENT	37	41	6,03%
MEASURING, ANALYZING, AND CONTROLLING INSTRUMENTS; PHOTOGRAPHIC, MEDICAL AND OPTICAL GOODS; WATCHES AND CLOCKS	38	121	17,79%
COMMUNICATIONS	48	2	0,29%
BUSINESS SERVICES	73	82	12,06%
ENGINEERING, ACCOUNTING, RESEARCH, MANAGEMENT, AND RELATED SERVICES	87	4	0,59%
Technology Companies		563	82,79%
OTHER MANUFACTURING	20-27, 29-34, 39	101	14,85%
OTHER NON-TECHNOLOGY COMPANIES	0-16, 49-59, 78, 80, 99	16	2,35%
Non-Technology Companies		117	17,21%
Total		680	100,0%

As can be seen from the table, most of the sample consists of technology firms, with 563 out of the total 680, which is about 83% of the sample. This means that there are 117 non-technology firms, or around 17% of the sample. The division for the technology and non-technology firms comes from Kallunki et al's 2009 paper and is done using the first two digits of the SIC-codes, where~~–~~ industries with SIC-codes starting with 28, 35-38, 48, 73 and 87 are considered technology companies and the rest are non-technology companies.

As can be seen from the sample the technology firms are highly represented in certain industries, for example, chemicals and allied products, industrial and commercial machinery and computer equipment, or business services. The most companies are from measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks, with 121 companies or 17,79% of the sample being from these industries. Two other very big groups are chemical and allied products, as well as electronics except computers, which hold 108 and 118 companies respectively or 15,88% and 17,35% each. Most of the non-technology companies are in other manufacturing industries, 101 of them, excluding of course the technology firms that are in manufacturing. Only 16 companies within the sample are from other industries than technology or manufacturing. These include for example, oil & gas extraction companies, wholesale trade companies, and~~or~~ health service companies.

4.2 Multiple Linear Regression Model

The multiple linear regression model is the integral part of the empirical part of this study, and it will be introduced in this section. Furthermore, the different variables of the model are introduced separately as well.

4.2.1 The Dependent Variables

As mentioned previously the dependent variables in this study will be the revenue growth -%, the return on assets (ROA), and the earnings before interest and taxes -percentage (EBIT-%). The decision to use revenue growth -% as the measure of firm growth came from the fact that

Chen et al (2005), Lee & Shim (1995) and Del Monte & Papagni (2003) also used revenue growth -%. The EBIT -% has also been used in previous research (see Lev & Sougiannis, 1996; Del Monte & Papagni, 2003), and was therefore chosen here as well to measure profitability. ROA has also been used in previous studies, such as Chen et al. (2005). Furthermore, the averages for 3, 5, and 9 years will be calculated for the revenue growth, return on assets, and earnings before interest and taxes –percentage, and they are used as dependent variables in the regressions. The idea to use averages stems from Kallunki et al (2009), as they used the 3-year and 5-year averages for earnings scaled to book value as the dependent variable in their regressions. However, the averages in this paper are calculated using a different method than those in Kallunki et al (2009).

For the revenue growth, the average is calculated using the compounded yearly average growth. This felt to be the most appropriate way to get a most accurate picture of the growth of revenue, due to high fluctuations within the yearly revenue growths. For the return on assets, the averages are calculated by summing together the net incomes for all the years and then dividing them by the sum of all the corresponding yearly total assets. This method was used due to the high fluctuations of net income in many of the companies in the data, where some years there was no income and during other years the net income was extremely high. Therefore, the yearly ROAs were not simply added together and divided by the years studied, as was the case in Kallunki et al (2009), where they averaged the percentages from the three or five years to get an average percentage of earnings to book value. The EBIT-% is calculated in the same way as the ROAs, for the same reasons.

The average 3-year(*RG3*) , 5-year(*RG5*), and the 9-year(*RG9*) revenue growth -% is calculated as follows:

$$RG3_i = \left(\frac{R_{i,t+3} - R_{i,t}}{R_{i,t}} + 1\right)^{\frac{1}{3}} - 1 \tag{1}$$

$$RG5_i = \left(\frac{R_{i,t+5} - R_{i,t}}{R_{i,t}} + 1\right)^{\frac{1}{5}} - 1 \tag{2}$$

$$RG9_i = \left(\frac{R_{i,t+9} - R_{i,t}}{R_{i,t}} + 1\right)^{\frac{1}{9}} - 1$$

(3)

Where,

$R_{i,t}$ = revenue for firm *i* at time *t*

The average 3-year(*ROA3*), 5-year(*ROA5*), and the 9-year(*ROA9*) return on assets is calculated as follows:

$$ROA3_i = \frac{\sum_{k=1}^{3} NI_{i,t+k}}{\sum_{k=1}^{3} AT_{i,t+k}}$$

(4)

$$ROA5_i = \frac{\sum_{k=1}^{5} NI_{i,t+k}}{\sum_{k=1}^{5} AT_{i,t+k}}$$

(5)

$$ROA9_i = \frac{\sum_{k=1}^{9} NI_{i,t+k}}{\sum_{k=1}^{9} AT_{i,t+k}}$$

(6)

Where,

$NI_{i,t}$ = net income for firm *i* at time *t*

$AT_{i,t}$ = total assets for firm *i* at time *t*

The average 3-year(*EBITP3*), 5-year(*EBITP5*), and the 9-year(*EBITP9*) return on equity is calculated as follows:

$$EBITP3_i = \frac{\sum_{k=1}^{3} EBIT_{i,t+k}}{\sum_{k=1}^{3} R_{i,t+k}}$$

(7)

$$EBITP5_i = \frac{\sum_{k=1}^{5} EBIT_{i,t+k}}{\sum_{k=1}^{5} R_{i,t+k}}$$

(8)

$$EBITP9_i = \frac{\sum_{k=1}^{9} EBIT_{i,t+k}}{\sum_{k=1}^{9} R_{i,t+k}}$$

(9)

Where,

$EBIT_{i,t}$ = earnings before interest and taxes for firm *i* at time *t*

$R_{i,t}$ = revenue for firm *i* at time *t*

4.2.2 The Primary Independent Variable

As the independent variable, we will use R&D-intensity. R&D-intensity has been calculated in multiple different ways in previous research. The two ratios that will be used in this research for R&D-intensity are the ratio between R&D expenditures and sales, (see e.g. Chan et al (1990), Chambers et al, 2002; Chan et al, 2001) and the ratio between R&D expenditures and total assets (Xu & Zhang, 2004). There have also been multiple papers were the ratio between R&D expenditures and market value of equity (see e.g. Lev & Sougiannis, 1996; Amir et al, 2007; Chambers et al, 2002) has been used as the measure for R&D intensity.

The benefits of R&D can span for up to ten years (Sougiannis, 1994; Chambers et al, 2002). Due to this, R&D expenditures of three years will be included in the calculations. Lev & Sougiannis (1996) estimated the amortization rates for companies in different industries. During the 5-year period they range from 9,5% (year 5, electrical and electronics industry) to 24,4% (year 3, scientific instruments industry). Chan et al (2001) used these figures to estimate an amortization rate of 20%. Based on the average rates estimated by Lev & Sougiannis (1996), this study will use an amortization rate of 18%. Furthermore, due to the R&D –intensity being highly positively skewed, we will take a natural logarithm of the R&D-intensity to normalize the distribution.

Thus, the R&D-intensity (*RDI_i*) will be calculated as follows:

$$RDI_{i,R} = ln\left(\frac{RD_{i,t} + 0,82 * RD_{i,t-1} + 0,64 * RD_{i,t-2}}{R_{i,t}}\right) = LNRDR3$$

(10)

Where,

$RD_{i,t}$ = r&d expenditure for firm *i* for year *t*

$R_{i,t}$ = revenue for firm *i* at time *t*

and

$$RDI_{i,A} = ln\left(\frac{RD_{i,t} + 0,82 * RD_{i,t-1} + 0,64 * RD_{i,t-2}}{AT_{i,t}}\right) = LNRDA3 \tag{11}$$

Where,

$RD_{i,t}$ = r&d expenditure for firm *i* for year *t*

$AT_{i,t}$ = total assets for firm *i* at time *t*

Furthermore, the R&D intensity will also be calculated by using a single year's R&D –intensity. In our case the year 2007 will be used:

$$RDI_{i,R,t} = ln\left(\frac{RD_{i,t}}{R_{i,t}}\right) = LNRDR \tag{12}$$

$$RDI_{i,A,t} = ln\left(\frac{RD_{i,t}}{AT_{i,t}}\right) = LNRDA \tag{13}$$

4.2.3 Control Variables

The control variables, which are also independent variables, will be firm size, the leverage of the firm and an industry dummy will be used for dividing the sample into low- and high-tech industries.

a) Past profitability

Kallunki et al (2009) used earnings scaled to book value (ROE) as a control variable in their research. In this paper, we will use return on assets for the year 2007 as our control variable. The reason for choosing ROA instead of ROE is due to many of the companies in our sample having negative book values and the assets being more stable and therefore giving a more accurate picture of the past profitability. We expect the past profitability to have positive values for the estimates, especially when looking at the regressions, where the average EBIT-% or average ROA are the dependent variables. Past earnings had a positive effect in Kallunki et al (2009) paper as well.

The return on assets for the year *t* (*ROA_07*) is calculated as follows:

$$ROA\_07_{i,t} = \frac{NI_{i,t}}{AT_{i,t}} \tag{14}$$

Where,

$NI_{i,t}$ = net income for firm *i* at time *t*

$AT_{i,t}$ = total assets for firm *i* at time *t*

b) Firm size

Firm size is often used as a control variable, when studying the effects of R&D. Kotabe et al (2002), Chan et al (2001), Lev & Sougiannis (1996), for instance, use size as a control variable in their research. The firm size can be calculated in multiple different ways, such as: using the amount of sales (see e.g. Kim, 2000; Del Monte & Papagni, 2003), the natural logarithm of sales (see e.g. Kotabe et al, 2002), the natural logarithm of total assets (see e.g. Lee & Shim, 1995), straight up market value (see e.g. Lev & Sougiannis, 1996), the natural logarithm of market value (see e.g. Amir et al, 2007; Chan et al, 2001; Kothari et al, 2002). In their research paper of 1995, Lee and Shim find that size has a positive effect on sales growth. Whereas for example, Lev & Sougiannis (1996) find that the size of a firm has a negative impact on the profitability of a firm. On the other hand, Kotabe et al (2002) find a positive relationship between ROA and size of a firm.

Kim's (2000) paper focuses particularly on the relationship between size and R&D. However, the study only focuses on the Korean information and telecommunications industry. Therefore, no generalizations can be drawn from it, but he does find that bigger firms, by either sales or size of workforce, spend more on R&D. Although the ratio decreases with size.

For this study the size of a firm (*LNFS*) is represented by the natural logarithm of the market value of the firm (see e.g. Kothari et al, 2002; Chan et al, 2001) at the end of the calendar year 2007.

$$LNFS_{i,t} = ln(MVE_{i,t}) \tag{15}$$

Where,
$MVE_{i,t}$ = market value of equity for firm *i* at the end of the year *t*

c) Leverage

Financial leverage is included as a control variable, as is the case in multiple of the previous research papers introduced in earlier sections. Lee & Shim (1995), for example, find that leverage has a negative effect on the growth of a company. While Amir et al (2007), Lev & Sougiannis (1996), for instance, find that leverage increases the profitability of the firm. It is important to note that higher leverage increases the risk and earnings variability of the firm as well (Kothari et al, 2002).

Leverage (*LEV*) in this study will be calculated as the amount of debt in current liabilities added together with long-term debt and then divided by the sum of long-term debt and the market value of equity at year 2007. This is the same way as Kothari et al (2002) have calculated leverage in their research paper.

$$LEV_{i,t} = \frac{(dlc_{i,t} + dltt_{i,t})}{(dltt_{i,t} + MVE_{i,t})} \tag{16}$$

Where,

$dlc_{i,t}$	= debt in current liabilities for firm *i* at time *t*
$dltt_{i,t}$	= long-term debt for firm *i* at time *t*
$MVE_{i,t}$	= market value of equity for firm *i* at the end of the year

d) Industry dummy

As an industry dummy (ID_i) we have used the same separation criterion of low-technology and high-technology companies as Kallunki et al (2009). This means that all he companies with a SIC-code, where the first two digits are 28, 35, 36, 37, 38, 48, 73, and 87, will be classified as high-technology companies, while the rest are considered low-technology companies. Therefore, the industry dummy value for high-tech companies will be 1, while the dummy value for low-tech companies will be 0.

4.2.4 The Regression Model

The regression model will be:

$$Y_i = \alpha + \beta_1 RDI_{i,t} + \beta_2 ROA\_07_{i,t} + \beta_3 LNFS_{i,t} + \beta_4 LEV_{i,t} + \beta_5 ID_i + \varepsilon_{i,t} \tag{17}$$

Where,

Y_i	= either the 3-, 5-, or 9-year average revenue growth (*RG*), the earnings before interest and taxes -percentage (*EBIT-%*), or the return on assets (*ROA*) for firm *i*
α	= Y intercept
$RDI_{i,t}$	= R&D-intensity for firm *i* at time *t* or the 3-year cumulative *RDI*
$ROA\_07_{i,t}$	= the return on assets for firm *i* at time *t*

$LNFS_{i,t}$	= firm size for firm *i* at time *t* calculated as the natural logarithm of market value of equity
$LEV_{i,t}$	= leverage of firm *i* at time *t* calculated as the ratio of debt in current liabilities added with long-term debt and divided by long-term debt plus market value of equity
ID_i	= industry dummy variable for firm *i*, will be 1 for high-tech firms and 0 for low-tech firms
$\varepsilon_{i,t}$	= error term

5 The Results and Analysis

In this section, we will discuss the results of the different analysis methods. Firstly, we will look at the descriptive statistics, including mean values, standard deviations, etc. Secondly, we will look at the correlation matrix, and investigate the Pearson correlations between different variables. Finally, we will study the results of the multiple linear regression analyses.

5.1 Descriptive Statistics

In figure 1, the progression of revenue and R&D expenditure for the companies in the sample during the years 2005-2016 can be seen. The revenue has increased in total from around $2 190B to about $3 080B, so an increase of over 40%. There has been a clear dip for the year 2009. This is most likely due to the financial crisis of 2008-2009. Furthermore, a second dip in the revenue comes for the years 2015 and 2016. Revenue decreased two years in a row, from almost $3 150B in 2014 to about $3 080B in 2016. For the 2009 dip, the real GDP of the US decreased by around 2,8%. On the other hand, for 2015 and 2016 the GDP of the US increased by 1,5% and 2,3% respectively (Statista, 22.5.2018). Therefore, it is reasonable to assume that the recession in the US economy affected the revenue growth of companies in 2009, however this should not be the case for 2015 and 2016. Some possible reasons could be for instance that some specific industries performed poorly in regards to revenue growth, or foreign competitors might have outperformed these firms.

Additionally, figure 1 shows the progression of R&D spending for the period of 2005-2016. During this period, the expenditure for R&D almost doubled for these companies from a bit over $100B in 2005 to a bit over $200B for 2016. For the years 2005-2014 the graph follows a similar progression to the bars that depict the amount of revenue, with an increase for every year except for the year 2009. However, whereas revenue decreased for 2015 and 2016, R&D expenditure kept increasing.

Figure 1. The yearly development of revenue and R&D expenditure for the data

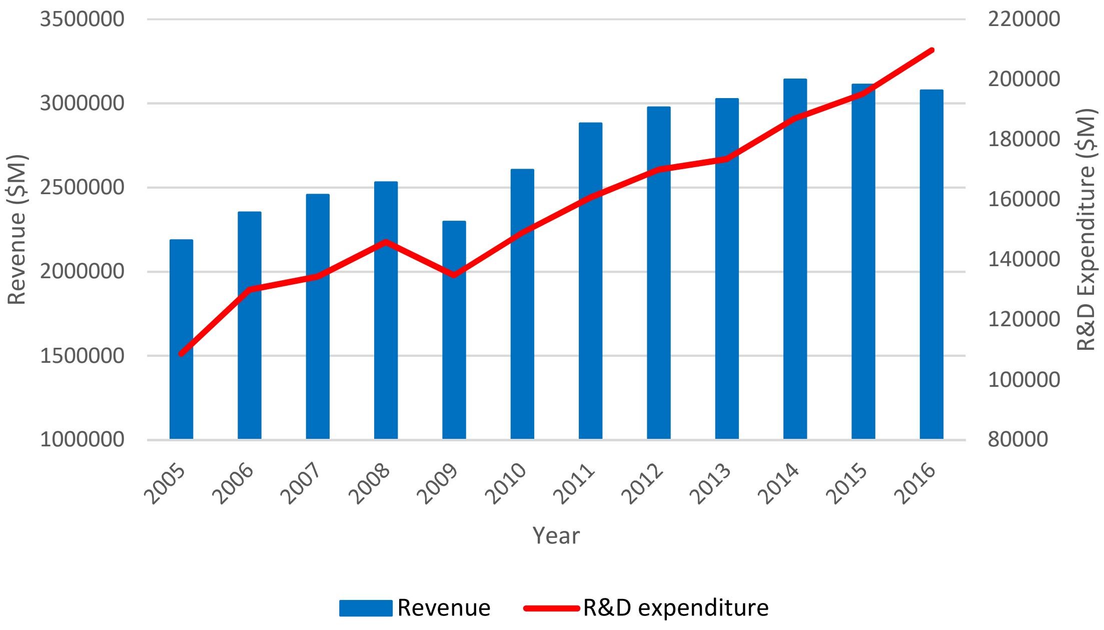

Table 2. The yearly development of R&D-intensity, revenue growth, and profitability

Year	Number of companies	RDR	RDA	RG	EBIT-%	ROA
2005	680	4,97 %	3,96 %	NA	11,55 %	5,13 %
2006	680	5,53 %	4,97 %	7,54 %	12,12 %	7,20 %
2007	680	5,47 %	4,88 %	4,46 %	11,96 %	5,54 %
2008	680	5,76 %	5,42 %	3,04 %	11,35 %	4,03 %
2009	680	5,87 %	4,46 %	-9,27 %	11,42 %	8,96 %
2010	680	5,72 %	4,55 %	13,39 %	13,96 %	7,16 %
2011	680	5,58 %	4,55 %	10,66 %	14,34 %	7,80 %
2012	680	5,71 %	4,50 %	3,29 %	14,25 %	6,92 %
2013	680	5,73 %	4,39 %	1,67 %	14,08 %	7,67 %
2014	680	5,95 %	4,52 %	3,84 %	14,10 %	7,33 %
2015	680	6,28 %	4,60 %	-0,96 %	14,54 %	6,93 %
2016	680	6,82 %	4,69 %	-1,10 %	14,48 %	6,78 %

Table 2 depicts the averages for the studied years for the R&D -intensity and the dependent variables: revenue growth, EBIT-% and ROA. As can be seen from the table, when R&D spending is scaled to revenue, the values are rather similar for the years 2005-2013, and then suddenly it starts to increase. This is likely due to the drop in the growth of revenue that was shown in figure 1. This is supported by the fact that the total R&D spending when scaled to total assets has not increased but stayed in the 4 % to 5 % range for the entire time-period, with the exceptions of 2006 and 2008, where it was a bit above 5 %.

For the average revenue growth, the figures represent the growth that was already seen in figure 1, where the years 2009, 2015 and 2016 have negative growth. The average EBIT-% can be divided into two distinct periods, the first one is from 2005 to 2009, where the Average EBIT-% is between 11,35% and 12,12%. The second period is from 2010 to 2016, where the average EBIT-% stay between 13,96% and 14,54%. The same can be said for the ROA, for the 2005-2009 period there is high fluctuations from a bit over 4% to almost 9%. Then again for the latter period of 2010 to 2016 it is more stable and stays between 6,78% and 7,8%..

In table 3, there are some descriptive statistics regarding the data. For every variable that is used in the regression; the minimum, mean, maximum, standard deviation, median and skewness are depicted in the table. From the minimum column, the most interesting values are for the different EBIT-%- -variables; all three averages have extremely high absolute values, when compared to their maximums. This is also the case for the ROA -variables, however to a lesser extent. For the revenue growth variables it is actually the opposite, where the maximums have higher absolute values than the minimums.

The means for all the EBIT-%- and ROA -variables are less than their medians, which indicates that the distribution is negatively skewed. The opposite is the case for revenue growth and for example leverage. This would indicate that they are positively skewed. The medians are all above 0, meaning that more than half of the companies in the sample have positive revenue growth, EBIT-% and ROA over all the 3-, 5-, and 9-year averages. However, the means are negative for the profitability measures. The different levels of skewness of the variables are shown in the far right column. The highest skewness is for the 9-year average EBIT-% at -10,082. This is not surprising as there can be big differences in earnings in different companies and different fiscal years. A skewness of 0 would indicate that the values are normally distributed. Revenue growth is around 1 for all the three averages. The primary independent variables, the R&D -intensities, are fairly close to a normal distribution and so is the size of a company.

Table 3. Descriptive Statistics

Variable	Number of observations	Minimum	Mean	Maximum	Std Dev	Median	Skewness
LNRDR	680	-5.527	-2.093	2.754	1.539	-2.076	0.429
LNRDA	680	-5.288	-2.295	0.543	1.194	-2.218	-0.094
LNRDR3	680	-6.518	-2.911	2.046	1.547	-2.888	0.436
LNRDA3	680	-6.396	-3.113	-0.106	1.197	-3.038	-0.097
ROA_07	680	-2.346	-0.007	0.335	0.221	0.052	-3.970
LNFS	680	1.278	6.553	12.060	2.180	6.590	0.080
LEV	680	0.000	0.121	0.846	0.152	0.064	1.633
ID	680	0.000	0.828	1.000	0.378	1.000	-1.742
RG3	680	-0.426	0.041	0.848	0.154	0.024	1.106
RG5	680	-0.299	0.053	0.619	0.119	0.039	1.079
RG9	680	-0.255	0.041	0.502	0.094	0.029	1.052
EBITP3	680	-12.697	-0.081	0.375	0.816	0.066	-9.885
EBITP5	680	-7.830	-0.033	0.376	0.547	0.072	-8.295
EBITP9	680	-10.516	-0.033	0.409	0.605	0.075	-10.082
ROA3	680	-1.380	-0.036	0.219	0.196	0.031	-2.610
ROA5	680	-1.312	-0.018	0.216	0.174	0.037	-2.947
ROA9	680	-1.366	-0.013	0.191	0.164	0.032	-3.450

5.2 Correlation Analysis

Before moving into the regression analysis, we will do a correlation analysis. This is done using correlation coefficients, which tell the magnitude of the relationship between two variables (Holopainen & Pulkkinen, 2008, p. 233). There are multiple different methods to measure correlation coefficients; however, in this study we will only use the Pearson correlation coefficient.

The Pearson correlation coefficient is used to measure interval or ratio variables, and the coefficient's value will always be between -1 and 1. A positive coefficient close to 1 will have a strong positive correlation, while a coefficient closer to 0 will have a smaller correlation. This is also the case for negative correlations. When the coefficient is closer to -1 then there is a stronger negative correlation, and closer to 0 indicates a weaker negative correlation (Bryman & Bell, 2011, p. 347). If the correlation coefficient is 0, then there is no linear relationship between the variables, however there could be a non-linear connection between the variables. It is important to note that Pearson's correlation coefficient only measures linear relationships. (Holopainen & Pulkkinen, 2008, p. 234-235).

It is important to note that correlation does not mean there is causation. Correlation does not necessarily mean that one variable affects the other (Holopainen & Pulkkinen, 2008, p. 259). Therefore, we will also conduct the regression analysis later on in the study. While the goal is to find correlation between the dependent and independent variables, having too strong correlation between independent variables could cause multicollinearity (Holopainen & Pulkkinen, 2008, p. 275). There is no clearly defined limit for too strong correlation between two variables. However, Taanila (2010) states that if the absolute value of the correlation is above 0,7, it should be investigated further. Furthermore, in the following section the variance inflation factor (VIF) will be used to determine whether there exists multicollinearity in the regression models (Holopainen & Pulkkinen, 2008, p. 279).

The statistical significance for the correlation coefficient will be 5% in this study. In other words, if the p-value is below 0,05, the correlation coefficient will be considered statistically significant. Moreover, the significance will be measured at 1% and 0,1% levels as well. If the significance is above 5%, it will be disregarded in the analysis. Furthermore, the correlation can be considered weak if the absolute value of the coefficient is below 0,35, and if the correlation is above 0,65 it can be considered to have a strong correlation (Creswell, 2008, p. 365).

Table 4 shows the correlation matrix for the Pearson correlation. In the table, all four of the RDI-variables have extremely high and statistically significant correlations with each other. This is not surprising, and it is not a point of concern, since they are never used in the same models. The correlation between the RDI-variables and the other control variables is more important in trying to determine whether there exists multicollinearity.

Past profitability correlates with all four RDI-variables at the 0,1% level. The correlation is negative and falls between -0,5 and -0,4. The size and the RDI-variables have statistically significant correlation at the 0,1% level, and the correlations are slightly negative between -0,241 and -0,155. This means that on average smaller firms have higher RDI. The leverage is also statistically significant for the RDI-variables. While the correlation is negative as was the case with size, the absolute value of the correlation is higher and falls between -0,3 and -0,35 for all four variables. This indicates that higher leveraged companies have smaller R&D - intensity. This could possibly be due to the funds that would have gone towards R&D going into interest expenses instead. Additionally, past profitability and size correlate positively at 0,349 with at 0,1% significance. Furthermore, the correlation between leverage and size is also statistically significant at the 0,1% level and has a correlation coefficient of 0,127, meaning that bigger companies tend to have a higher leverage ratio.

The correlation for the technology dummy and the RDI-variables is highly significant and positive. The correlation for all the RDI's and the technology dummy are between 0,41 and 0,42. The positive and relatively high correlation was expected, as it is generally the case that high technology companies have more R&D spending (Lee & Shim, 1995). In this sample, at least the past profitability and size of a firm correlate negatively with the industry dummy and are significant at the 1% level. This indicates that tech-companies have less profitability and are smaller than non-tech companies. This is also the case with leverage, where the correlation between the technology dummy and leverage is negative at -0,172 and is significant at the 0,1% level. This suggests that tech-companies have lower leverage than non-technology companies.

Table 4. Pearson correlation matrix

	LNRDR	LNRDA	LNRDR3	LNRDA3	ROA_07	LNFS	LEV	ID	RG3	RG5	RG9	ROE3	ROE5	ROE9	ROA3	ROA5	ROA9
LNRDR	1,0000																
LNRDA	**0,9167**	1,0000															
	<,0001																
LNRDR3	**0,9946**	**0,9068**	1,0000														
	<,0001	<,0001															
LNRDA3	**0,9141**	**0,9909**	**0,9182**	1,0000													
	<,0001	<,0001	<,0001														
ROA_07	**-0,4785**	**-0,4138**	**-0,4664**	**-0,4003**	1,0000												
	<,0001	<,0001	<,0001	<,0001													
LNFS	**-0,1678**	**-0,2402**	**-0,1546**	**-0,2237**	**0,3488**	1,0000											
	<,0001	<,0001	<,0001	<,0001	<,0001												
LEV	**-0,3095**	**-0,3292**	**-0,3174**	**-0,3406**	-0,0102	**0,1267**	1,0000										
	<,0001	<,0001	<,0001	<,0001	0,7911	0,0009											
ID	**0,4138**	**0,4075**	**0,4154**	**0,4113**	**-0,1237**	**-0,1131**	**-0,1691**	1,0000									
	<,0001	<,0001	<,0001	<,0001	0,0012	0,0031	<,0001										
RG3	**0,3081**	**0,1741**	**0,3242**	**0,1965**	**-0,2014**	0,0413	**-0,1493**	**0,1073**	1,0000								
	<,0001	<,0001	<,0001	<,0001	<,0001	0,2827	<,0001	0,0051									
RG5	**0,2214**	**0,0966**	**0,2373**	**0,1183**	**-0,2399**	0,0599	**-0,1396**	0,0610	**0,7640**	1,0000							
	<,0001	0,0117	<,0001	0,0020	<,0001	0,1187	0,0003	0,1123	<,0001								
RG9	**0,2737**	**0,1793**	**0,2854**	**0,1958**	**-0,1456**	0,0001	**-0,1639**	**0,0789**	**0,5844**	**0,7647**	1,0000						
	<,0001	<,0001	<,0001	<,0001	0,0001	0,9984	<,0001	0,0396	<,0001	<,0001							
EBITP3	**-0,4321**	**-0,2911**	**-0,4302**	**-0,2908**	**0,4318**	**0,1710**	0,0573	-0,0781	-0,0205	**-0,1487**	**-0,1882**	1,0000					
	<,0001	<,0001	<,0001	<,0001	<,0001	<,0001	0,1355	0,0417	0,5942	<,0001	<,0001						
EBITP5	**-0,4667**	**-0,3236**	**-0,4641**	**-0,3225**	**0,4501**	**0,2259**	**0,0840**	**-0,0883**	-0,0193	-0,0468	**-0,1327**	**0,9322**	1,0000				
	<,0001	<,0001	<,0001	<,0001	<,0001	<,0001	0,0286	0,0213	0,6163	0,2226	0,0005	<,0001					
EBITP9	**-0,4443**	**-0,3189**	**-0,4433**	**-0,3199**	**0,4369**	**0,2112**	**0,0941**	**-0,0868**	**-0,1478**	-0,0198	-0,0198	**0,6028**	**0,7330**	1,0000			
	<,0001	<,0001	<,0001	<,0001	<,0001	<,0001	0,0141	0,0237	0,0001	0,6062	0,6062	<,0001	<,0001				
ROA3	**-0,5029**	**-0,3999**	**-0,4909**	**-0,3867**	**0,6458**	**0,3770**	**0,0959**	**-0,1278**	-0,0039	-0,0338	-0,0565	**0,5599**	**0,6205**	**0,5495**	1,0000		
	<,0001	<,0001	<,0001	<,0001	<,0001	<,0001	0,0124	0,0008	0,9186	0,3787	0,1411	<,0001	<,0001	<,0001			
ROA5	**-0,5089**	**-0,4115**	**-0,4962**	**-0,3974**	**0,6309**	**0,3704**	**0,1061**	**-0,1281**	-0,0002	0,0143	-0,0167	**0,5791**	**0,6764**	**0,5887**	**0,9372**	1,0000	
	<,0001	<,0001	<,0001	<,0001	<,0001	<,0001	0,0056	0,0008	0,9961	0,7091	0,6632	<,0001	<,0001	<,0001	<,0001		
ROA9	**-0,5168**	**-0,4261**	**-0,5059**	**-0,4145**	**0,6397**	**0,3847**	**0,1263**	**-0,1440**	-0,0472	-0,0012	0,0546	**0,5555**	**0,6637**	**0,6336**	**0,8455**	**0,9336**	1,0000
	<,0001	<,0001	<,0001	<,0001	<,0001	<,0001	0,0010	0,0002	0,2189	0,9753	0,1551	<,0001	<,0001	<,0001	<,0001	<,0001	

Underneath the correlation coefficients is the significance level. Bolded coefficients are significant at the 0,05 level at least. Number of observations = 680.

The revenue growth variables can be seen to correlate positively with all four RDI-variables. Furthermore, the correlations are significant at the 0,1% level, except for the correlation between RG5 and LNRDA, as well as RG5 and LNRDA3, whose correlations are significant at the 5% level and 1% level respectively. There is a clear difference in the correlation when R&D spending is scaled using revenue or total assets. The correlation is higher for the RDI that has been scaled by revenue, by about 0,1. As the correlation is positive, this would indicate that higher R&D spending would enhance revenue growth, which is in line with our first hypothesis. Past profitability correlates negatively with revenue growth and is significant at the 0,1% level, and has values ranging from -0,240 to -0.146. The correlation between size and revenue growth is not significant for any of the three RG-variables. The leverage on the other hand, is significant for all three and has a negative correlation of about -0,15 for all three RG-variables. Finally, the RD dummy is statistically significant for the 3-year and 9-year average revenue growth and has a positive value of about 0,1, suggesting that technology firms have a slightly higher revenue growth when compared to non-technology firms.

For the EBIT-% -variables the correlation is negative and between -0,5 and -0,25. The absolute value is the highest for the 5-year regression. This result is rather interesting, as it would suggest that higher R&D spending has an adverse relationship with the EBIT-%. The past profitability and EBIT-% have correlation values at about 0,40 to 0,45, with significance of 0,1%. This shows that companies that have been profitable in the past are likely profitable in the future as well. The size has also a positive correlation with the EBIT-% -variables and is statistically significant at the 0,1% level. The correlation has values between 0,15 and 0,25. The leverage is only significant for the 5-year and 9-year average EBIT-%, and it increases the EBIT-%, as the correlation coefficients are 0,084 and 0,094. The technology dummy correlates negatively with the 5-year and 9-year EBIT-% -variables and is around -0,09 for both variables. This means that technology companies seem to have worse returns on equity, and even more so in the longer run.

The ROA-variables have even higher negative correlation with the RDI-variables, with some having absolute values higher than 0,5. Moreover, they are all statistically significant at the 0,1% level. The absolute values seem to be higher for the correlations with the RDI-variables that are scaled to revenue rather than to total assets. This was also the case with EBIT-% and revenue growth. The past profitability correlates strongly at around 0,65 with the ROA as it is the ROA of 2007, which was used as the measure for past profitability. Further indicating that previous profitability correlates with future profitability to a certain extent. They are significant at the 0,1% level. As was the case with EBIT-%, the size of the firms correlates positively with the ROAs. However, the variation in the size of the correlation is smaller as it falls in between 0,35 and 0,4. The correlation between leverage and the ROA-variables is also statistically significant and the values are between 0,09 and 0,13 and it increases with the longer studied period, meaning that over a longer time the effects of leverage become more significant. The technology dummy has a slight negative correlation and is statistically significant for all three ROAs. Once more suggesting that technology firms have lower ROA's than non-technology firms.

The correlations from the Pearson correlation matrix indicate that the R&D spending correlates positively with revenue growth. This would support our first hypothesis. However, the opposite was the case for the profitability measures EBIT-% and ROA, where the correlation was highly negative. This would oppose our second hypothesis. However, we will proceed to the regression analysis to get a more comprehensive picture of the effects of R&D.

5.3 Regression Analysis

This section will focus on the effects of R&D investments on growth and profitability with the help of the multiple linear regression analyses using the ordinary least squares (OLS-method) method. These multiple linear regression analyses allow us to research how multiple variables influence one specific variable, in a ceteris paribus environment (Wooldridge, 2009, p. 68).

The correlation analysis conducted in the previous section studied the collinearity between two variables, and as was shown, the independent variables did not correlate too strongly in any of the models to cause concern. As mentioned previously, in order to investigate the multicollinearity between variables, we will use the variance inflation factor (VIF). Generally, the VIF-value should not exceed 5, if it does the value with the highest VIF-value should be removed from the study (Holopainen & Pulkkinen, 2008, p. 279). In all the regressions, using the different RDI-variables, the VIF-values were between 1,15 and 1,75, making it highly unlikely that there would be any issues with multicollinearity.

Our regression analysis will include the estimates for the coefficients, the p-values of all the coefficients, the adjusted R-squared, number of observations, and the F-statistic. The output of the p-values tests the significance of each explanatory variable. The significance levels that will be shown in the results include: ***<0.001, **<0.01, *<0.05, .<0.1. However, even if we include the .<0.1 significance level, it will merely be used as additional information, and we do not consider the underlying estimate to be statistically significant enough to be considered as credible evidence towards our final evaluation of the effects of the models.

The intercept will also be included in the analysis. However, the intercept is of no importance in our study, as it only indicates the value that the dependent variable would achieve if all the other values were 0. This is an impossibility, since there is no case, where all the independent values could be zero, as a firm for example, has to have a market value.

Each regression is also assessed with the adjusted R-squared and the F-statistic. The adjusted R-squared measures how much of the changes of the dependent variable the model can explain by using the independent variables, taking into account the number of independent variables in the model (Holopainen & Pulkkinen, 2008, p.277-278). The adjusted R-squared value is expressed as a decimal that can be converted to percentages by multiplying it by 100, meaning that if adjusted R-squared is 0,1 it means that the model explains 10% of the dependent variable's changes. The adjusted R-squared is more useful than R-squared because it takes the amount of observations into account. The F-statistic shows the overall significance of the model, it tests for the hypotheses that all parameters are 0. The F-statistic also has a p-value and the same significance limits as the parameter coefficients (Wooldridge, 2009, p. 145). In order for the model to be statistically significant in this study, the p-value of the F-statistic has to be below 0.05.

5.3.1 The Effect of Firm R&D on Revenue Growth

In the following four tables, 5-8, are the results of the multiple linear regressions regarding a company's revenue growth. The first two tables, 5 and 6, R&D –intensity is measured with the cumulative R&D expenses for three years scaled by revenue and total assets. While in tables 7 and 8 are the results for the regressions using a single year scaled by revenue and total assets.

Table 5 holds the results for the multiple linear regression with the cumulative R&D expenses scaled by revenue measuring the revenue growth of a company. As can be seen from the table, the model's adjusted R-squared for the 3-year average revenue growth is 0,1143. This means that the model is able to explain 11,43% of the revenue growth for the 3-year average revenue growth. The R-squared decreases for the following 5-year and 9-year averages. This is not entirely surprising, as it would seem logical that as the time from when the independent variables are measured extends, the accuracy of the model decreases. The R-squared for the 5-year average is 0,1062 and 0,0820 for the 9-year average. The F-statistic is highly significant for all three models at the 0,1 % significance level.

The coefficient for R&D –intensity, LNRDR3, is significant at the 0,1 % significance level for the 3-year and 9-year average regressions. However, it is only significant at the 10% level for the 5-year average, which is not considered statistically significant in this paper. The estimate of the coefficient LNRDR3 for the 3-year average is 0,0240, while the value of the coefficient for the 9-year average revenue growth is 0,0145. There is a significant drop in the effect of R&D spending from the 3-year to the regressions to the 9-year average regression. This would indicate that the effect of R&D lessens with time. However, the 5-year average coefficient is even smaller, at 0,0067, than that of the 9-year average, but again this value is not statistically significant.

The coefficient for R&D –intensity, LNRDR3, is significant at the 0,1 % significance level for the 3-year and 9-year average regressions. However, it is only significant at the 10% level for the 5-year average, which is not considered statistically significant in this paper. The estimate of the coefficient LNRDR3 for the 3-year average is 0,0240, while the value of the coefficient for the 9-year average revenue growth is 0,0145. There is a significant drop in the effect of

R&D spending from the 3-year to the regressions to the 9-year average regression. This would indicate that the effect of R&D lessens with time. However, the 5-year average coefficient is even smaller, at 0,0067, than that of the 9-year average, but again this value is not statistically significant.

Table 5. The regression model with revenue growth as the dependent variable and LNRDR3 as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	0,0404	0,149887	0,0157	0,471024	0,0666	0,000133 ***
LNRDR3	0,0240	6,24E-07 ***	0,0067	0,073362 .	0,0145	1,11E-06 ***
ROA_07	-0,0962	0,002117 **	-0,1437	5,19E-09 ***	-0,0262	0,17429
LNFS	0,0099	0,000343 ***	0,0101	3,55E-06 ***	0,0030	0,075365 .
LEV	-0,0969	0,014580 *	-0,1103	0,000367 ***	-0,0651	0,008004 **
ID	-0,0038	0,816091	-0,0033	0,794505	-0,0093	0,358976
Adjusted R Squared	0,1143		0,1062		0,0820	
Observations	680		680		680	
F-statistic p-value	2,20E-16		5,71E-16		3,27E-12	

Signif. Codes: ***=0,001, **=0,01, *=0,05, ,=0,1
LNRDR3 is the natural logarithm of the 3-year cumulative R&D-intensity with revenue being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

The coefficient for R&D –intensity, LNRDR3, is significant at the 0,1 % significance level for the 3-year and 9-year average regressions. However, it is only significant at the 10% level for the 5-year average, which is not considered statistically significant in this paper. The estimate of the coefficient LNRDR3 for the 3-year average is 0,0240, while the value of the coefficient for the 9-year average revenue growth is 0,0145. There is a significant drop in the effect of R&D spending from the 3-year to the regressions to the 9-year average regression. This would indicate that the effect of R&D lessens with time. However, the 5-year average coefficient is

even smaller, at 0,0067, than that of the 9-year average, but again this value is not statistically significant.

As can be seen from the values of the parameters, the coefficients for the effect of R&D are positive as was expected in the hypothesis, and this would indicate that R&D has a positive effect on the revenue growth of a company. Yet, the coefficients are small, for example as was mentioned previously for the 3-year average, the effect of R&D –intensity for technology firms is only 0,0240. This means that if the R&D –intensity increases by 1 %, a company's revenue growth would increases by 0,0240 percentage points. Even if the effect of R&D seems rather small, it still supports the idea that R&D investments can have an impact on a company's growth, whether it be 3 or 9 years into the future.

Out of the control variables, the past profitability and the size are significant in some of the three models, while leverage is significant for all three models. The industry dummy, ID, however is not significant in any of the three models. The past profitability as measured by the ROA for 2007 is significant for the 3- and 5-year average regressions at the 1% and 0,1% levels respectively. The effect of the ROA is negative with values of -0,0962 for the 3-year average and -0,1437 for the 5-year average. The size of the firm, LNFS, is significant at the 0,1% level for the 3-year and 5-year average models, and the values of the coefficients are 0,0099 and 0,0101, making their impact less than that of R&D. The leverage, LEV, on the other hand, is significant at the 5% level for the 3-year average, and the coefficients have negative values of -0,0969. This illustrates for example that a company with a leverage ratio of 1 will have 9,7 percentage points less revenue growth for the 3-year average. The leverage coefficient is also significant at the 0,1% level for the 5-year average and at the 1% level for the 9-year average. The values are also negative, at -0,1103 and -0,0651 respectively. Additionally, the intercept is highly significant on the 0,1% level in the 9-year average model. However, as mentioned before the intercept holds no value in this study.

In table 6, the 3-year cumulative R&D -intensities are calculated using total assets as the denominator. In these models the adjusted R-squares range from 0,0543 to 0,1052, meaning that on average these models do not explain as much of the revenue growth as the previous models. Unlike the previous regressions, where the adjusted R-squared decreased with the increased timeframe of the study, in these regressions the 5-year average has the highest adjusted R-Squared. This could possibly be due to the economic environment stabilizing after the 2008 financial crisis. The F-statistics significance levels are similar to the previous models, where each model is significant at the 0,1% level.

Table 6. The regression model with revenue growth as the dependent variable and LNRDA3 as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0,0196	0,500006	-0,0250	0,261	0,0401	0,025340 *
LNRDA3	0,0059	0,328714	-0,0073	0,115	0,0072	0,053789 .
ROA_07	-0,1624	8,51E-08 ***	-0,1795	2,03E-14 ***	-0,0592	0,001451 **
LNFS	0,0112	7,66E-05 ***	0,0102	2,60E-06 ***	0,0039	0,025635 *
LEV	-0,1494	0,000219 ***	-0,1441	3,44E-06 ***	-0,0891	0,000353 ***
ID	0,0216	0,190649	0,0125	0,322	0,0025	0,805087
Adjusted R -Squared	0,0823		0,1052		0,0543	
Observations	680		680		680	
F-statistic p-value	2,91E-12		8,10E-16		4,26E-08	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDA3 is the natural logarithm of the 3-year cumulative R&D-intensity with total assets being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

The variable depicting the R&D expenses, LNRDA3, is not statistically significant in any of the three regression. However, it is significant at the 10% level for the 9-year average regression, and almost significant at the 5 % level with a p-value of 0,0538. The values of the parameter for the 9-year average revenue growth is 0,0072, which is smaller than in the previous three regressions. However, it is important to note that it is only significant at the 10% level, which is too low and can therefore not be considered evidence towards the hypothesis.

When comparing these results to the previous results in table 5, the parameter for the profitability of the company is statistically significant for all three regressions, whereas it was only significant for the 3-year and 5-year regressions in table 5. Furthermore, the effect is negative here as well. This supports the previous results that past profitability has a negative effect on revenue growth. The effect of past profitability is considerably higher for the 3-year and 5-year average regressions and drops to about a third for the 9-year average regression from -0,1795 for the 5-year average regression to -0,0592 for the 9-year average regression.

The size of a company is significant at the 0,1% level for the 3-year and 5-year average regressions. As was the case formerly, the coefficient values are small at 0,0112 and 0,0102, having a slight positive impact on revenue growth. Additionally, it is also significant at the 5% level for the 9-year regression, but the value of the parameter is even lower at 0,0039. Furthermore, the parameters for leverage are highly significant for these regressions, as the significance level for all three regressions is 0,1%. The coefficients are all negative with values of -0,1494, -0,1441, and -0,0891 respectively, as was the case with the former regressions. This is in line with the view that a higher leverage decreases revenue growth. The industry dummy is not significant for any regressions.

The results for the regressions with a single year's R&D scaled by revenue are shown in table 7. The results of these regressions are similar to the results of the regressions with 3-year cumulative R&D scaled by revenue, as can be expected. The adjusted R-squares are 0,1220, 0,1093 and 0,0873 respectively, which are slightly higher than for the LNRDR3 –regressions. As was the case with both previous models the F-statistic is significant at the 0,1% level for all three regressions.

As was the case with the regressions with the 3-year cumulative R&D scaled by revenue, the R&D –intensity was statistically significant for the 3-year and 9-year average regressions at the 0,1 % level. However, even the 5-year average regression's LNRDR was significant at the 5% level, whereas in the 3-year cumulative R&D regressions it was not statistically significant. The values of the coefficients were 0,0265 for the 3-year average, 0,0087 for the 5-year average, and 0,0155 for the 9-year average regression. It is interesting that the 5-year average regression has the lowest parameter value, as it was expected that the effect would decrease over time.

Table 7. The regression model with revenue growth as the dependent variable and LNRDR as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	0,0712	0,018817 *	0,0297	0,2082	0,0834	1,00E-05 ***
LNRDR	0,0265	2,93E-08 ***	0,0087	0,0185 *	0,0155	1,44E-07 ***
ROA_07	-0,0894	0,003902 **	-0,1375	1,77E-08 ***	-0,0236	0,2176
LNFS	0,0096	0,000518 ***	0,0099	5,04E-06 ***	0,0029	0,0935 .
LEV	-0,0876	0,027032 *	-0,1039	0,0008 ***	-0,0608	0,0133 *
ID	-0,0074	0,65018	-0,0061	0,6321	-0,0108	0,2827
Adjusted R -Squared	0,1220		0,1093		0,0873	
Observations	680		680		680	
F-statistic p-value	< 2,2E-16		< 2,2E-16		4,92E-13	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDR is the natural logarithm of the 1-year R&D-intensity with revenue being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

The control variables were similarly significant as was the case in the regressions with the 3-year cumulative R&D scaled by revenue, with past profitability being significant for the 3-year and 5-year average regressions, and statistically not significant for the 9-year average regression. The size was significant for the 3-year and 5-year average regressions at the 0,1% level. While the leverage was significant for all three regressions at a 5% significance level, and for the 5-year average regression at the 0,1% level. The coefficients had similar values in the regressions with the 3-year cumulative R&D scaled by revenue. The industry dummy, ID, was not significant at any level.

Table 8 depicts the three regression with a single year's R&D scaled by total assets. The adjusted R-squares are between 0,0575 and 0,1029. This is similar to the 3-year cumulative R&D –intensity regressions, with the 5-year average regression having the highest adjusted R-squared. Furthermore, the F-statistics are again all significant at the 0,1% level.

The R&D –intensity measure is only statistically insignificant at the 5% level for the 9-year average regression. On the other hand, the 3-year and 5-year average regressions are not statistically significant. The parameter value are for the 9-year average regression is positive at 0,0091. This collaborates the previous results that R&D spending has a positive effect on revenue growth.

Table 8. The regression model with revenue growth as the dependent variable and LNRDA as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	0,0011	0,973407	-0,0193	0,434	0,0531	0,007585 **
LNRDA	0,0102	0,088393 .	-0,0039	0,396	0,0091	0,014450 *
ROA_07	-0,1543	3,04e-07 ***	-0,1727	1,47E-13 ***	-0,0558	0,002498 **
LNFS	0,0112	7,21e-05 ***	0,0103	2,04E-06 ***	0,0038	0,026525 *
LEV	-0,1391	0,000601 ***	-0,1372	1,08E-05 ***	-0,0841	0,000766 ***
ID	0,0171	0,298337	0,0092	0,465	0,0005	0,960038
Adjusted R -Squared	0,0850		0,1029		0,0575	
Observations	680		680		680	
F-statistic p-value	1,14E-12		1,90E-15		1,47E-08	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDA is the natural logarithm of the 1-year R&D-intensity with total assets being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

The past profitability is significant for all three regressions, similarly to the 3-year cumulative R&D expenses scaled to total assets, with the 3-year and 5-year regressions being significant at the 0,1% level and the 9-year regression significant at the 1% level. Furthermore, the values are negative once again. The coefficient for the effect of the size of the firm is statistically significant at the 0,1% level for the 3-year and 5-year average regressions, and at the 5% level for the 9-year average regression, with values of 0,0112, 0,0103 and 0,0038 respectively . These are extremely close to all of the previous regression. Leverage is statistically significant for all three regressions at the 0,1% level. The parameter values are -0,1391 for the 3-year average regression, -0,1372 for the 5-year average regression, and finally, -0,0841 for the 9-year regression. All of these would indicate again that higher leverage has a negative effect on the revenue growth of a firm. Finally, the industry dummy is not statistically significant for any of the regressions.

The results from these regressions with revenue growth as the dependent variable indicate that higher R&D spending has a positive influence on revenue growth. It is interesting that for the 5-year average regression there seems to be some event for the added two years 2011 and 2012 from the 3-year average regression that decreased the effect of R&D, while increasing the effect of past profitability. Another observation is that past profitability and leverage seem to have a negative impact on revenue growth, even more so in the shorter term for leverage. The size of a firm on the other hand, has a positive impact on the revenue growth of the firm.

5.3.2 The Effect of Firm R&D on EBIT-%

Tables 9-12 contain the results for the multiple linear regressions regarding the EBIT-%. As was the case with the revenue growth, the first two tables, 8 and 9, the R&D –intensity is measured with the cumulative R&D expenses for three years, scaled to revenue and total assets. All the while in tables 10 and 11 are the results for the regression using only the single year R&D expenses scaled by the revenue and total assets of every company.

Firstly, in table 9 the average 3-, 5-, and 9-year EBIT-% are calculated using the 3-year cumulative RD –intensity measures. The adjusted R-squares for the three regressions are 0,2565, 0,2948, and 0,2690. It is interesting to note that the adjusted R-squared is highest for the 5-year average regression. The F-statistic is significant at the 0,1% level for all three regressions.

The variable measuring R&D’s effect on EBIT-%, LNRDR3, is significant in the 3-, 5-, and 9-year average regressions at the 0,1% level. However, contrary to previous expectations, the values of the parameters are all negative at -0,1868, for the 3-year average, -0,1373 for the 5-year average, and -0,1383 for the 9-year average regression. However, the values are rather small, as a 1 % increase in R&D –intensity would decrease EBIT-% by 0,1383 percentage points for the 9-year average regression, for instance. Nonetheless, the effect is clearly higher for the 3-year average regression than for the 5-year or 9-year average regressions.

Table 9. The regression model with EBIT-% as the dependent variable and LNRDR3 as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0,7044	2,82E-07 ***	-0,5832	9,96E-11 ***	-0,5811	9,00E-09 ***
LNRDR3	-0,1868	3,18E-15 ***	-0,1373	< 2,2E-16 ***	-0,1383	2,05E-15 ***
ROA_07	0,9678	2,83E-10 ***	0,6116	1,03E-09 ***	0,6959	6,68E-10 ***
LNFS	0,0135	0,31276	0,0227	0,00966 **	0,0208	0,03470 *
LEV	-0,1990	0,29985	-0,0943	0,45203	-0,0207	0,88312
ID	0,2117	0,00764 **	0,1563	0,00260 **	0,1569	0,00714 **
Adjusted R -Squared	0,2565		0,2948		0,269	
Observations	680		680		680	
F-statistic p-value	< 2,2E-16		< 2,2E-16		< 2,2E-16	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDR3 is the natural logarithm of the 3-year cumulative R&D-intensity with revenue being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

The past profitability is highly significant with a 0,1% significance level, and the parameter's estimates are high between 0,6116 and 0,9678 for the three regressions. This indicates that past profitability has a high effect on future profitability. The size of the firm is significant at the 1% level for the 5-year regression and at the 5% level for the 9-year regression. The coefficient estimates are 0,0227 and 0,0208 respectively. This would mean that the firms with a higher market value the year before, our measure for size of a firm, have higher EBIT-%. The leverage of a company is not significant for any of the regressions. The industry dummy, on the other hand, is significant at the 1% level for all three regressions. This would mean that technology firms have a higher EBIT-%, when compared to non-technology firms.

Table 10 shows the results for the regression where, R&D –intensity is measured by the 3-year cumulative R&D spending scaled by total assets. The adjusted R-squares are lower in comparison to previous regressions, and follow a similar pattern to the regression results of table 9, meaning that the adjusted R-squared is lowest for the 3-year average regression and is highest for the 5-year average regression at 0,1968 for the former and 0,2248 for the latter. The 9-year average regression has an adjusted R-squared of 0,2130. The F-statistic is significant at the 0,1% level for all three regressions.

Table 10. The regression model with EBIT-% as the dependent variable and LNRDA3 as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0,3726	0,00969 **	-0,3487	0,000251 ***	-0,3608	0,00066 ***
LNRDA3	-0,0955	0,00141 **	-0,0736	0,000194 ***	-0,0801	0,00027 ***
ROA_07	1,3850	< 2,2E-16 ***	0,9115	< 2,2E-16 ***	0,9865	< 2,2E-16 ***
LNFS	0,0028	0,84125	0,0147	0,108184	0,0127	0,21508
LEV	0,1023	0,60718	0,1197	0,361715	0,1823	0,21238
ID	0,0633	0,43784	0,0506	0,346756	0,0563	0,34724
Adjusted R - Squared	0,1968		0,2248		0,213	
Observations	680		680		680	
F-statistic p-value	< 2,2E-16		< 2,2E-16		< 2,2E-16	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1

LNRDA3 is the natural logarithm of the 3-year cumulative R&D-intensity with total assets being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

The R&D –intensity measure is significant at the 1% level for the 3-year regression and at the 0,1% level for the 5-year and 9-year regressions. The parameter values are about half of the values from the previous regression, starting from -0,0955, followed by -0,0736, and finally, ending at -0,0801. They follow the similar pattern as well. Moreover, the coefficient values are negative as was the case previously.

The past profitability is the only control variable that is significant and has a significance level of 0,1%. All the estimate values are positive and are 1,3850, 0,9115, and 0,9865 respectively for the 3-year, 5-year, and 9-year average regression. All of the other control variables are not statistically significant at any level or in any of the three regressions.

The results for the regressions with a single year's R&D scaled by revenue with the average EBIT-% as dependent variables are shown in table 11. The adjusted R-squares for the 3-, 5-, and 9-year average regressions are 0,2581, 0,2964, and 0,02714, which is similar to the results from the previous regressions that were scaled by revenue. The F-statistic is significant for all three regressions at the 0,1% level.

Table 11. The regression model with EBIT-% as the dependent variable and LNRDR as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0,8697	5,24E-09 ***	-0,7035	6,96E-13 ***	-0,7067	1,19E-10 ***
LNRDR	-0,1873	1,52E-15 ***	-0,1374	< 2,2E-16 ***	-0,1395	6,56E-16 ***
ROA_07	0,9740	1,71E-10 ***	0,6171	5,80E-10 ***	0,6980	4,59E-10 ***
LNFS	0,0152	0,25831	0,0239	0,00651 **	0,0221	0,02518 *
LEV	-0,2198	0,25334	-0,1088	0,38685	-0,0383	0,78625
ID	0,2153	0,00663 **	0,1586	0,00223 **	0,1607	0,00582 **
Adjusted R -Squared	0,2581		0,2964		0,2714	
Observations	680		680		680	
F-statistic p-value	< 2,2E-16		< 2,2E-16		< 2,2E-16	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDR is the natural logarithm of the 1-year R&D-intensity with revenue being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

The coefficient for the R&D –intensity for technology firms is significant at the 0,1% level for the 3-, 5-, and 9-year average regressions. As was the case with the 3-year cumulative R&D –intensity scaled by revenue, the coefficient values are negative, and are almost identical in value. This further suggests that having larger R&D spending has an adverse effect on the EBIT-% of a company.

The control variables have similar significance levels as in the other EBIT-% regressions, where R&D was scaled to revenue. The past profitability, being highly significant at 0,1% levels, while the size is significant for the 5-year and 9-year average regressions. The leverage is not significant in any of the three regressions and the industry dummy is significant at the 1% level for all three regressions. The values of the coefficients are also extremely similar to those in table 9.

Finally, in table 12 are the results for the regressions with a single year's R&D scaled by total assets. The adjusted R-squares follow the same trend as the 3-year cumulative RDI scaled to total assets, with the adjusted R-squares being 0,1982 for the 3-year regression, 0,2263 for the 5-year regression, and 0,2150 for the 9-year regression. The F-statistic has a significance level of 0,1% for all three regressions.

Out of the measure of R&D spending all coefficients are significant at the 0,1% level, and as can be expected the results are similar to the previous regressions regarding EBIT-%, with negative values that have similar estimated values as those with the 3-year cumulative RDIs scaled to total assets. The coefficient values are -0,1003, -0,0767, and -0,0848 for the three regressions.

Additionally, only the past profitability is significant of the control variables and is highly positive as was the case previously. The other control variables are not statistically significant at any level for any of the three regressions. However, size is significant at the 10% level for the 5-yuear regression, and is positive, but no conclusions can be drawn from this as the significance level is not good enough.

Table 12. The regression model with EBIT-% as the dependent variable and LNRDA as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0,4735	0,003063 **	-0,4242	6,01E-05 ***	-0,4478	0,000140 ***
LNRDA	-0,1003	0,000755 ***	-0,0767	9,60E-05 ***	-0,0848	0,000106 ***
ROA_07	1,3796	< 2,2E-16 ***	0,9086	< 2,2E-16 ***	0,9807	< 2,2E-16 ***
LNFS	0,0035	0,799414	0,0153	0,0944 .	0,0133	0,192813
LEV	0,0815	0,683435	0,1051	0,4251	0,1633	0,265521
ID	0,0697	0,393229	0,0549	0,3076	0,0623	0,298
Adjusted R - Squared	0,1982		0,2263		0,2150	
Observations	680		680		680	
F-statistic p-value	< 2,2E-16		< 2,2E-16		< 2,2E-16	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDA is the natural logarithm of the 1-year R&D-intensity with total assets being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

The results from these regressions imply that the high R&D decreases the EBIT-% during all the years of the study, which is contradictory to previous research introduced in this study. Furthermore, unsurprisingly past profitability calculated by ROA seems to correlate positively with future EBIT-%.

5.3.3 The Effect of Firm R&D on ROA

The results for the multiple linear regressions concerning the effects of R&D on ROA are contained in tables 13-16. Tables 13 and 14 measure R&D –intensity with the cumulative R&D expenses for three years scaled to revenue and total assets. Tables 15 and 16 on the other hand show the results for regressions, where the RDI is based on only the R&D spending in 2007 and scaled to revenue and total assets, as was done previously regarding the regressions of revenue growth and EBIT-%.

The adjusted R-squares for the regressions using 3-year cumulative R&D expenses as the measure of R&D –intensity are between 0,4794 and 0,4958, which can be seen in table 13. This is relatively high in comparison to the previous regressions, whether for revenue growth or EBIT-%. Furthermore, there does not seem to be the pattern that the adjusted R-squared follows. Additionally, all of the F-statistics are significant at the 0,1% level.

Table 13. The regression model with ROA as the dependent variable and LNRDR3 as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0,2402	< 2,2E-16 ***	-0,2058	< 2,2E-16 ***	-0,1889	2,67E-16 ***
LNRDR3	-0,0356	3,16E-14 ***	-0,0336	2,07E-15 ***	-0,0306	6,35E-15 ***
ROA_07	0,4057	< 2,2E-16 ***	0,3443	< 2,2E-16 ***	0,3308	< 2,2E-16 ***
LNFS	0,0159	3,43E-09 ***	0,0140	7,83E-09 ***	0,0138	7,91E-10 ***
LEV	0,0030	0,9367	0,0094	0,7842	0,0302	0,3423
ID	0,0338	0,0315 *	0,0323	0,0226 *	0,0241	0,0668 .
Adjusted R -Squared	0,4916		0,4794		0,4958	
Observations	680		680		680	
F-statistic p-value	< 2,2E-16		< 2,2E-16		< 2,2E-16	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDR3 is the natural logarithm of the 3-year cumulative R&D-intensity with revenue being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

The RDI indicator, LNRDR3, is significant in all three regressions, with a significance level of 0,1% for the three regressions. The coefficient values increase from -0,0356 in the 3-year average regression to -0,0336 for the 5-year average regression and finally to -0,0306 for the 9-year average regression. This means that increased R&D spending decreases the ROA, as was the case with EBIT-%. However, in this case the effect lessens as the studied time-period is increased.

Of the control variables, the past profitability is significant at the 0,1% level for the three regressions and has a positive value that decreases with a longer study-period from 0,4057 to 0,3308. The size has also statistical significance in all three regressions. The size is significant at the 0,1% level in all regressions and has a value between 0,0138 and 0,0159 for all three regressions, meaning that as size measured by market value has a positive effect on the ROA of a company. Leverage is not significant at the any level for any of the three regressions.

The industry dummy is significant at the 1% level for the 3-year and the 5-year average regressions. The value decreases from 0,0338 in the 3-year regression to 0,0323 for the 5-year regression. This suggests that technology companies had on average about 3% higher average ROA for these two time-periods.

In table 14 are the results for the regression where, R&D –intensity is measured by the 3-year cumulative R&D spending scaled to total assets and ROA is the dependent variable. The adjusted R-squares are between 0,4438 and 0,4636. The adjusted R-squares are again high compared to the regression with a different dependent variable, especially with regards to revenue growth. However, they are smaller than for the previous regressions with ROA as the dependent variable. The F-statistic is once more significant at the 0,1% level for all three regressions.

The variable depicting R&D spending in this regression, LNRDA3, is significant at the 0,1% level for the three average regressions. Additionally, the estimates of the coefficients are quite close to those of the previous regression. Moreover, the values of the coefficients are all negative indicating that once more R&D spending has an adverse effect on ROA. It should be noted that the estimate value does not decrease with the extended study-period, the effect is about the same for all three regressions.

Table 14. The regression model with ROA as the dependent variable and LNRDA3 as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0,1868	8,76E-11 ***	-0,1614	4,88E-10 ***	-0,1507	3,31E-10 ***
LNRDA3	-0,0219	0,000215 ***	-0,0229	1,84E-05 ***	-0,0216	1,22E-05 ***
ROA_07	0,4782	< 2,2E-16 ***	0,4083	< 2,2E-16 ***	0,3875	< 2,2E-16 ***
LNFS	0,0138	6,37E-07 ***	0,0119	1,71E-06 ***	0,0119	2,33E-07 ***
LEV	0,0527	0,180198	0,0515	0,146	0,0668	0,0417 *
ID	0,0091	0,57055	0,0112	0,441	0,0056	0,6756
Adjusted R -Squared	0,4574		0,4438		0,4636	
Observations	680		680		680	
F-statistic p-value	< 2,2E-16		< 2,2E-16		< 2,2E-16	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDA3 is the natural logarithm of the 3-year cumulative R&D-intensity with total assets being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

As was the case with the previous regression, the past profitability and the size of the company seem to have a positive effect on the ROA. They are also highly significant at the 0,1% level for all three regressions. The values of the parameters for past profitability range from 0,3875 for the 9-year regression to 0,4782 for the 3-year regression. The size's parameter values are 0,0119 for both the 5-year and 9-year average regressions and 0,0138 for the 3-year average regression. The leverage of a firm is only significant at the 5% level for the 9-year average regression. The value of the parameter is 0,0668. The fact that the value is positive is within expectations, since this was the case, for example, in the studies of Amir et al (2007) and Lev & Sougiannis (1996). The industry dummy is not significant for any of the three average regressions.

Table 15 shows the results for the regressions with a single-year RDI scaled to revenue of a firm. The adjusted R-squares range from 0,4765 to 0,4940, meaning that they are very similar to the results from the regressions with 3-year cumulative RDI scaled to revenue. Furthermore, as was the case previously all the F-statistics are significant at the 0,1% level.

Table 15. The regression model with ROA as the dependent variable and LNRDR as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0,2667	< 2,2E-16 ***	-0,2301	< 2,2E-16 ***	-0,2124	< 2,2E-16 ***
LNRDR	-0,0345	1,40E-13 ***	-0,0324	1,43E-14 ***	-0,0298	2,10E-14 ***
ROA_07	0,4110	< 2,2E-16 ***	0,3497	< 2,2E-16 ***	0,3347	< 2,2E-16 ***
LNFS	0,0162	2,27E-09 ***	0,0142	5,30E-09 ***	0,0141	4,88E-10 ***
LEV	0,0026	0,9452	0,0095	0,7841	0,0294	0,3585
ID	0,0329	0,0371 *	0,0312	0,0282 *	0,0235	0,0743 .
Adjusted R -Squared	0,4894		0,4765		0,494	
Observations	680		680		680	
F-statistic p-value	< 2,2E-16		< 2,2E-16		< 2,2E-16	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDR is the natural logarithm of the 1-year R&D-intensity with revenue being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

In these three regressions the parameter for R&D spending is significant for all three regressions at the 0,1%, which was the case for the previous two models as well. The coefficient values are approaching zero as the time period lengthens, with values from -0,0345 for the 3-year parameter, -0,0324 for the 5-year parameter, and -0,0298 for the 9-year parameter. This is similar to the 3-year cumulative RDI scaled to revenue regressions. As has been the case with the profitability measures, R&D seems to have a negative impact on the profitability of a firm.

The past profitability and size parameters are once again highly significant with all being at the 0,1% level. The coefficient values for the past profitability are between 0,3347 and 0,4110. The values for the size are between 0,0141 and 0,0162, making it very similar to the 3-year cumulative RDI scaled to revenue regressions' results. Also, the leverage is not significant in any of the three regressions. Meanwhile, the industry dummy is significant for the 3-year and 5-year average regressions. The significance level is 5% and the values range from 0,0329 and 0,0312 respectively.

Finally, the results of the fourth set of regressions with ROA as the dependent variable are depicted in table 16. The adjusted R-squares are 0,4564, 0,4422, and 0,4628 respectively for the 3-, 5- and 9-year average regressions. These are similar to the 3-year cumulative RDI scaled to total assets regressions with ROA as the dependent variable. In addition, the F-statistics of all three regressions are again significant at the 0,1% level.

Table 16. The regression model with ROA as the dependent variable and LNRDA as the measure for RDI

	3-year average		5-year average		9-year average	
Independent Variables	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-0,2022	2,57E-10 ***	-0,1769	8,34E-10 ***	-0,1672	3,43E-10 ***
LNRDA	-0,0208	0,00041 ***	-0,0216	4,90E-05 ***	-0,0209	2,08E-05 ***
ROA_07	0,4811	< 2,2E-16 ***	0,4116	< 2,2E-16 ***	0,3896	< 2,2E-16 ***
LNFS	0,0140	4,40E-07 ***	0,0122	1,13E-06 ***	0,0121	1,49E-07 ***
LEV	0,0528	0,18166	0,0520	0,145	0,0660	0,0452 *
ID	0,0084	0,60143	0,0103	0,479	0,0053	0,6925
Adjusted R -Squared	0,4564		0,4422		0,4628	
Observations	680		680		680	
F-statistic p-value	< 2,2E-16		< 2,2E-16		< 2,2E-16	

Signif. Codes: ***=0.001, **=0.01, *=0.05, .=0.1
LNRDA is the natural logarithm of the 1-year R&D-intensity with total assets being the denominator at time t-1, ROA_07 is the return on assets at t-1, LNFS is the natural logarithm of the market value of equity at t-1, LEV is the leverage at time t-1, and ID is the industry dummy.

As has been the case with all profitability regressions the RDI variable's coefficient is significant at the 0,1% level for all three regressions. Furthermore, the coefficient values are similar and range between -0,0208 and -0,0216. As was the case with the 3-year cumulative

RDI scaled to total assets, there is no distinct pattern to the way the coefficient values increase or decrease.

As has been the case with all regressions with ROA as the dependent variable past profitability and size have a positive impact on the ROA, and they are significant at the 0,1% level for all three regressions. The parameter values range between 0,3896 and 0,4811 for past profitability and between 0,0121 and 0,0140 for size. The estimate for leverage is significant at the 5% level for the 9-year average regression and has a negative value of 0,0660. It is not significant in the other two regressions. The industry dummy is not significant in any of the three regressions.

The results for the regressions with ROA as the dependent variable follow along the same lines as EBIT-% in the sense that high RDI has a negative impact on profitability. However, for ROA, when it is scaled to revenue the effect decreases with the longer studied time-periods. In all the regressions concerning ROA, past profitability and size had positive impact, and was highly significant at the 0,1% level. However, past profitability had a notably higher effect than size. Leverage was significant for some of the 9-year average regression and the impact was positive. The industry dummy had an effect when the R&D spending was scaled to revenue, and those regressions indicated that the technology companies had a ROA that would be about 3% better than for the non-technology companies.

5.4 Limitations

There are some limitations in the study that should be considered with regards to the result and the process itself. The results are most likely not generalizable due to some of the aspects of the sample. Firstly, it is restricted to the US based companies, which can be considered a rather special market with regards to R&D due to them treating R&D differently in the financial statements compared to most countries in the World. Also, the division between technology and non-technology companies is a bit out of balance, with a lot more tech-firms in the sample. Furthermore, restricting the sample to companies that have engaged in R&D over the entire period, removing companies with missing data, and removing outliers have ruled out a lot of companies from the study. Additionally, even with the removal of outliers, there still seem to be some companies with very low minimums for some of the dependent variables.

The time frame of the study can be regarded as limited, as it could have been even larger. However, the choice was made to see how the financial crisis could have affected the dependent variables and thus the line for the independent and dependent variables was drawn between 2007 and 2008. However, this could have had an effect on the results for the regression, especially in regards to the profitability measures.

The choice for the variables was based on previous research. It can be argued whether the chosen are the best variables to explain the revenue growth or profitability. It is possible that some relevant variables are omitted from this research. Moreover, it could be argued whether using the averages for the dependent variables is the correct choice. The division of tech and non-tech companies comes from Kallunki et al (2009), but the technology dummy, could have been divided into multiple dummy variables. However, that would have left some sections even smaller than the non-technology group. Moreover, the reasoning for choosing the control variables comes from previous studies and it is not certain, if there are other variables that would explain some of the growth or profitability. Some of the control variables used in other studies regarding R&D that have not been used here are, for example, the amount of advertising (Lee & Shim, 1995; Sougiannis, 1994), book-to-market ratio (Lev & Sougiannis, 1996), or capital intensity or capital expenditures(Kothari, Laguerre & Leone, 2002; Lee & Shim, 1995).

The choice to primarily only use OLS multiple linear regression analysis as the tool in the study to find the connection between R&D and revenue growth and profitability, could be considered a limitation. There could have been more fitting options available or there could have been more methods in addition to the descriptive statistics, correlation analysis and the regression analysis.

6 Conclusions and Summary

The goal of this study was to firstly examine the connection between R&D spending and a company's revenue growth, secondly the connection between a company's R&D spending and profitability. The data that was used contained 680 publicly traded US-based companies, and consisted of 8160 firm-year observations, over twelve years from 2005 to 2016. While, the first three years, where used to find the R&D-intensity of firms and 2007 was the base-year for control variables, the data from the following nine years 2008-2016 was used to study the growth and profitability of the firms. The 3-, 5-, and 9-year averages of revenue growth, EBIT-% and ROA were used as the dependent variables in the study.

The study reviewed the accounting standard SFAS No. 2, which is the standard in the US GAAP that establishes how R&D expenditure should be treated in financial accounting and reporting. Furthermore, the IAS 38 was discussed, which examines the treatment of intangible assets and R&D -spending in financial statements, in jurisdictions that follow the IFRS standard. The biggest difference between the US GAAP and the IFRS standard lies within the fact that the IFRS allows development costs to be capitalized under certain circumstances. The SFAS No. 2, on the other hand, clearly states that all R&D spending has to be expensed, and none of it can be capitalized.

The third section of this paper went through some of the previous research regarding how R&D should be treated in financial statements. There were differing results and opinions in previous research, but maybe one consensus was that having R&D capitalized would make financial statements more relevant, but it could have an adverse effect on the reliability of the financial statements. Furthermore, previous research concerning the effect of R&D on revenue growth and profitability was examined. Most of the research found that increased R&D spending had a positive effect on a company's growth. The research regarding profitability was not as indisputable, although most previous research found that higher R&D increases profitability. This was especially the case, when a technology firm had higher R&D spending, then they would benefit in both growth and profitability. Based on the previous research and its results the hypotheses were formed. The first being that R&D increases revenue growth, and the second that R&D increases a company's profitability.

Following the previous research, the data and the regression model that were used in the study were introduced. The restrictions of the data were considered and explained. The variable selections for the multiple linear regression were discussed and justified, and the regression model in general was presented. Some descriptive statistics regarding the data were shown. In general R&D spending has increased as a whole, however the R&D -intensity has stayed rather static over the studied period, with the exception of the last 2-3 years in the study, where the R&D scaled to revenue increased. However, this was likely due to the overall drop in revenues for the studied companies during 2015 and 2016. In general, revenue increased with the exception of 2008, 2015, and 2016. EBIT-% for the studied period was between 11%-15% per year, while ROA was between 5% and 9%, except for 2008, where it dipped below 5%. This was most likely due to the financial crisis. Furthermore, the means for EBIT-% and ROA were negative, giving some indication that the regression for EBIT-% and ROA would not conform to our hypothesis regarding profitability.

A correlation analysis was conducted in order to find the possible correlations between the different variables. The revenue growth and profitability variables had correlations with many of the independent variables. The RDI variables had positive correlation with revenue growth, while the correlation was negative regarding the profitability measures. This further implied that our second hypothesis might not be correct, while the first seemed to be. Moreover, technology firms seemed to correlate negatively with profitability, while past profitability, size and leverage correlated positively. Revenue growth correlated negatively with past profitability and leverage, but either positively or not statistically significantly with the tech-dummy. Furthermore, size was not significant. The independent variables did not correlate too strongly with each other, so there was no concern for multicollinearity. Additionally, the VIF-values discussed further on in the paper did not find any multicollinearity issues either.

According to the multiple linear regression analysis regarding revenue growth R&D spending is in fact positively correlated with the revenue growth of a firm, as we anticipated with our first hypothesis. These results are in line with the results from previous research, for instance, Lee & Shim (1995), Chen etal (2005), Garcia-Manjon & Romero-Marino (2012), etc. Furthermore, the regressions, where RDI was measured using revenue for scaling, had higher adjusted R-squares, meaning that their explanatory power was greater. Additionally, the regressions where the RDI was scaled to revenue were mostly statistically significant, while the regressions where RDI was scaled to assets were mostly not statistically significant. The RDI had a positive effect on revenue growth in the regressions, where it was statistically significant. Out of the control variables, the past profitability, the size and leverage were statistically significant for most regressions. Past profitability and leverage had a negative impact on the revenue growth. However, the size had a positive impact. The results regarding the effect of the size and leverage of a firm are similar to what Lee and Shim (1995) found in their research. The industry dummy was not significant in any regression or at any level.

The results for profitability of a firm were not consistent with our hypothesis. The results for the regressions with EBIT-% and ROA as dependent variables showed that higher R&D – intensity has a negative impact on profitability. This is contrary to previous research (see e.g. Lev & Sougiannis, 1996; Kallunki et al, 2009; Chan et al, 1990). Furthermore, the effect was stronger for EBIT-% than for ROA. Most of the previous research was focused on the effects of R&D regarding stock prices and stock returns, thus it could explain partially why the results are inconsistent with previous research. As could be expected, the past profitability had a positive impact on profitability. Additionally, the size of the firm had a positive impact on profitability, as was the case with Kotabe et al (2002), but contrary to Lev & Sougiannis (1996). Leverage was mostly not statistically significant, but when it was it had a positive impact as well. However, it was only significant in two of the 9-year regressions. This was also found in the research of Amir et al (2007) and Lev & Sougiannis (1996). The industry dummy was significant for some of the regressions and the results indicated that high-tech companies have higher profitability than low-tech companies. As was the case with the revenue growth regressions, the regression with RDI scaled to revenue had more explanatory power than those that were scaled to total assets.

These partially inconsistent results, when compared to previous research open up new and multiple possibilities for future research concerning the effects of R&D spending. For instance, this study only included companies with consistent R&D spending during the entire process. Therefore, including companies with no R&D spending could be interesting with modern data. Furthermore, only publicly traded US based companies were included in this study, there could be multiple directions that could be taken from here. For instance, having only companies that are not publicly traded, or increasing the geographical scope, with comparisons between the US and for example Europe. Another possible direction for a study could be to have a more detailed division of industries in order to discover the differences between the effects of R&D depending on the industry. Moreover, more variables or different variables for profitability could make for an intriguing study. It is probable that with the increasing amount of R&D spending and overall use of technology in society, the study of R&D spending and possible topics of study will likely only increase in the future.

References

Aboody, D. & Lev, B. (1998). The Value Relevance of Intangibles: The Case of Software Capitalization. *Journal of Accounting Research*, Vol. 36 Supplement 1998, 161-191.

Amir, E., Guan, Y., & Livne, G. (2007). The Association of R&D and Capital Expenditure with Subsequent Earnings Variability. *Journal of Business Finance & Accounting*, 34(1-2), 222-246.

Bryman, A. & Bell, E. (2011). Business Research Methods, 3rd Edition. Oxford University Press Inc., New York.

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

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

Chan, L. K., Martin, J. D., & Kensinger, J. W. (1990). Corporate Research and Development Expenditures and Share Value. *Journal of Financial Economics*, 26, 255-276.

Chen, M. C., Cheng, S. J., & Hwang, Y. (2005). An empirical investigation of the relationship between intellectual capital and firms' market value and financial performance. *Journal of intellectual capital*, Vol. 6(2), 159-176.

Cobb, C. W. & Douglas, P. H. (1928). A Theory of Production. *The American Economic Review*, Vol. 18 (1), 139-165.

Corrado, C., Hulten, C., & Sichel, D. (2009). Intangible Capital and U.S Economic Growth. *Review of Income and Wealth, International Association for research in Income and Wealth*, 55(3), 661-685.

Creswell, J. W. (2008). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research, Third Edition. Pearson Education Inc., Upper Saddle River, New Jersey 07458.

Del Monte, A. & Papagni, E. (2003). R&D and the Growth of Firms: Empirical Analysis of a Panel of Italian Firms. *Research Policy*, 32, 1003-1014.

Erickson, G. & Jacobson, R. (1992). Gaining Comparative Advantage Through Discretionary Expenditures: The Returns to R&D and Advertising. *Management Science*, Vol. 38 (9), 1264-1279.

Fama, E. F. & French, K. R. (1992). The Cross-Section of Expected Stock Returns. *The Journal of Finance,* Vol. 47 (No. 2), 427-465.

Financial Accounting Standards Board (1974). Statement of Financial Accounting Standards No. 2: Accounting for Research and Development Costs.

Financial Accounting Standards Board (1985). Statement of Financial Accounting Standards No. 86: Accounting for the Costs of Computer Software to Be Sold, Leased or Otherwise Marketed.

García-Manjón, J. V. & Romero-Merino, M. (2012). Research, development, and firm growth. Empirical evidence from European top R&D spending firms. *Research Policy*, Vol. 41 (6), 1084-1092.

Holopainen, P. & Pulkkinen P. (2008). Tilastolliset menetelmät, 5. painos (5th edition), WSOY oppimateriaalit Oy, Suomi(Finland).

Høegh-Krohn, N. E. J. & Knivsflå, K. H. (2000). Accounting for Intangible Assets in Scandinavia, the UK, the US and by the IASC: Challenges and a Solution. *The International Journal of Accounting*, Vol. 35 (2), 243-265.

International Accounting Standards 38: *Intangible Assets* (2010).

International Accounting Standards, Regulation (EC) No 1606/2002.

Kallunki, J-P., Pyykkö, E. & Laamanen, T. (2009). Stock Market Valuation, Profitability and R&D Spending of the Firm: The Effect of Technology Mergers and Acquisitions. *Journal of Business Finance & Accounting*, Vol. 36(7) & (8), 838-862.

Kim, P. R. (2000). R&D and Firm Sizes in the Information and Telecommunications industry of Korea. *Small Business Economics*, Vol. 15 (3), 183-192.

Kotabe, M., Srinivasan, S. S., & Aulakh, P. S. (2002). Multinationality and Firm Performance: The Moderating Role of R&D and Marketing Capabilities. *Journal of International Business Studies*, Vol 33 (1), 79-97.

Kothari, S. P., Laguerre, T. E., & Leone, A. J. (2002). Capitalization versus Expensing: Evidence on the Uncertainty of Future Earnings from Capital Expenditures versus R&D Outlays. *Review of Accounting Studies*, 7, 355-382.

Lee, J. & Shim, E. (1995). Moderating Effects of R&D on Corporate Growth in the U.S. and Japanese Hi-Tech Industries: An Empirical Study. *The Journal of High Technology Management Research*, Vol. 6 (2), 179-191.

Lev, B. & Sougiannis, T. (1996). The capitalization, amortization, and value-relevance of R&D. *Journal of Accounting and Economics*, 21, 107-138.

Lev, B. & Zarowin, P. (1999). The Boundaries of Financial Reporting and How to Extend Them. *Journal of Accounting Research*, Vol 37 (2), 353-385.

Morbey, G. K. (1988). R&D: Its Relationship to Company Performance. *Journal of Product Innovation Management,* Vol. 5 (3), 191-200.

Morbey, G. K. & Reithner, R. M. (1990). How R&D Affects Sales Growth, Productivity and Profitability. *Research Technology Management*, Vol. 33 (3), 11-14.

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

Penman, S. H. and Zhang, X-J. (2002). Accounting Conservatism, the Quality of Earnings and Stock Returns. *The Accounting Review,* Vol. 77 (2), 237-264.

Powell, S. (2003). Accounting for intangible assets: current requirements, key players and future directions. *European Accounting Review,* 12:4, 797-811.

Sougiannis, T. (1994). The Accounting Based Valuation of Corporate R&D. *The Accounting Review*, Vol. 69 (1), 44-68.

Wooldridge, J. M. (2009). Introductory Econometrics: A Modern Approach, Fourth Edition. South-Western, Cengage Learning. Canada.

Xu, M. & Zhang, C. (2004). The explanatory power of R&D for the cross-section of stock returns: Japan 1985-2000. *Pacific-Basin Finance Journal*, Vol. 12 (3), 245-269.

Webpages:

Financial Accounting Standards Board. About the FASB, (Accessed 27.11.2017): *http://www.fasb.org/jsp/FASB/Page/SectionPage&cid=1176154526495*

OECD. OECD Data, Gross domestic spending on R&D, (Accessed 29.11.2017): *https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm*

Statista, Aalto University, Real GDP growth of the United States from 1990 to 2017, (Accessed 22.5.2018): *https://www.statista.com/statistics/188165/annual-gdp-growth-of-the-united-states-since-1990/*

Taanila, A. (2010). Lineaariset regressiomallit, (Accessed 28.5.2018): *http://myy.haaga-helia.fi/~taaak/m/regressio.pdf*

The World Bank. Databank, Research and development expenditure (% of GDP), (Accessed 24.11.2017): *https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS*

The World Bank. Databank, United States, (Accessed 24.11.2017): *https://data.worldbank.org/country/united-states*

Appendices

Appendix A

Here is a division of all the companies in the sample by their 2-digit SIC-code

Industry	Two-digit SIC-code	Number of Firms	Percentage
Agricultural Production – Crops	01	1	0,15%
Oil & Gas Extraction	13	2	0,29%
Heavy Construction, Except Building	16	1	0,15%
Food & Kindred Products	20	13	1,91%
Tobacco Products	21	1	0,15%
Textile Mill Products	22	2	0,29%
Lumber & Wood Products	24	2	0,29%
Furniture & Fixtures	25	11	1,62%
Paper & Allied Products	26	10	1,47%
Printing & Publishing	27	3	0,44%
Chemical & Allied Products	28	108	15,88%
Petroleum & Coal Products	29	2	0,29%
Rubber & Miscellaneous Plastics Products	30	12	1,76%
Leather & Leather Products	31	2	0,29%
Stone, Clay, & Glass Products	32	8	1,18%
Primary Metal Industries	33	5	0,74%
Fabricated Metal Products	34	21	3,09%
Industrial Machinery & Equipment	35	87	12,79%
Electronic & Other Electric Equipment	36	118	17,35%
Transportation Equipment	37	41	6,03%
Instruments & Related Products	38	121	17,79%
Miscellaneous Manufacturing Industries	39	9	1,32%
Communications	48	2	0,29%
Electric, Gas, & Sanitary Services	49	1	0,15%
Wholesale Trade – Durable Goods	50	3	0,44%
Wholesale Trade – Nondurable Goods	51	1	0,15%
Eating & Drinking Places	58	1	0,15%
Miscellaneous Retail	59	1	0,15%
Business Services	73	82	12,06%
Motion Pictures	78	1	0,15%
Health Services	80	3	0,44%
Engineering & Management Services	87	4	0,59%
Non-Classifiable Establishments	99	1	0,15%
Total		680	100,0 %