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R&D Expenditures and Subsequent Market Performance

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Abstract

Currently, research on companies' market return following investments in research and development has been performed predominantly in the U.S. The objective of this research is, therefore, to examine the relationship between Swedish firms' investments in R&D and their subsequent market return. Finally, while adjusting for other potential sources of risk we find a considerable positive relationship between investments in R&D and market return. Our results suggest either a continuous mispricing by the market or a premium for the additional risk factor accompanied by R&D, leaning towards the former. The observed effect is smaller than those found in earlier research, indicating that perhaps the IFRS's perception of R&D expenditures is preferable to that of the U.S. GAAP.

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1. Introduction

1.1 Background Description

Intangible assets and R&D are an increasingly substantial part of a company's value, which makes their valuation more and more important for investors to understand. Whether it is employees in a company, patents or R&D, they have an enormous impact on what the value of a company truly is. They are also inherently difficult to measure, for the company itself but especially for investors. Firms investing heavily in R&D are some of the biggest companies in the world, Apple, Facebook, Microsoft and Oracle for instance, and it is crucial for investors to understand those types of companies and where the value of them stem from. Investors take multiple variables into account when choosing which companies to invest in but also in what way they value them. One of those variables consists of reading the financial statements from the company itself and based on that information making judgments about what they perceive the value of that company to be, but the margin for error is great. Unlike tangible assets such as a warehouse or equipment used in the warehouse, intangible assets are not physical in their nature and it makes them difficult for the company to measure and difficult for investors to interpret. R&D, or research and development, which is where the focus of our efforts will lie also garner a new set of uncertainties as it is expensed immediately according to the GAAP accounting standards of the USA (ASC 730). The IFRS accounting standards for Europe state that the R&D is to be expensed immediately except for when the company has come further along in the process (IAS 38).

To understand why investors misvalue or add a risk premium to R&D investments, it is important to understand how assets and companies are priced. The CAPM, or Capital Asset Pricing Model, was developed in the 1960's by Treynor, Sharpe, Lintner, and Mossin who all independently contributed to earlier work done by Harry Markowitz on the modern portfolio theory and diversification. CAPM uses the systematic risk (market beta) of a security to predict its price, but studies have shown that this model is generally unreliable on its own. Lintner tested the CAPM in 1965 by assessing the returns of 301 stocks and realized in the process that, due to attenuation bias, the CAPM does not hold. Fama and MacBeth, in 1973,

also tested the CAPM and found that the results were inconsistent. Finally, Richard Roll in 1977 suggested, in opposition to the previous studies, that the problem is not that the CAPM is inconsistent or that it does not hold. The problem is that it was not yet possible to observe a comprehensive enough market portfolio(F. Perold, 2004).

Fama and French (1993) developed the Three-Factor Model based off of the CAPM. The model was developed by adding size and value (book-to-market value) to the systematic risk already present in the CAPM. The Three-Factor Model was an improvement to the CAPM, because it adjusted for the tendency for value and small-cap stocks to outperform the market.

The valuation of businesses investing highly on R&D are essential in a post-industrial economy where the value of companies is abstract to a further extent. Moreover, there lies an inherent difficulty in valuing internally developed intangible assets which makes companies with a substantial amount of it prone to misvaluation. R&D projects are characterized by high uncertainty, which is apparent in the U.S. accounting standards as they are expensed instantly. However, previous research has shown that the perceived riskiness of R&D investments might be exaggerated (Baruch, 2004). With this in mind, there is reason to believe that companies with a substantial amount of investments in R&D are consistently undervalued. To see if there is a systemic misevaluation, the thesis would inquire about Swedish companies' investments into research and development and the stocks' risk-adjusted return during subsequent years. Whether the undervaluation is due to investors not recognizing the true value of investment in R&D or if they compensate for extra risk, there is still an issue there. As previously mentioned the R&D investment is expensed immediately as per the accounting standards of the GAAP and parts of the R&D is expensed immediately according to the IFRS. However, if it is true that R&D investment generates value that investors are not accounting for then there is an argument for R&D not to be expensed immediately but to be included in the balance sheet as an intangible asset. If investors instead are compensating for the higher degree of uncertainty or risk, then there is an argument for the GAAP and the IFRS to include minimum disclosure requirements for the specific investments into R&D in order to minimize the degree of asymmetric information. Examining the relationship between a firm's investments in R&D and its ensuing returns, would allow us to answer the following question:

- Are Swedish companies' investments in R&D consistently misvalued?

1.2 Aim of the study

Understanding R&D expenditure and the effect it has on the performance of companies is crucial. It is important in a world where some of the most important and valuable companies are to a large extent valuable because of their ability to innovate. The purpose of this study is to enquire if investors consistently misvalue Swedish companies investments in research and development.

1.3 Limitations of the study

The research will be limited to companies listed on the Swedish Stock Exchange. Based on later specified sample criteria this results in 61 firms studied. Similar research done by Lev & Sougiannis (1994) on the U.S. financial market used a sample of 2 600 firms in their regression models. This limitation is a natural consequence of the difference in size of the Swedish and U.S. market. Our sample of 61 firms, while small in comparison, is however tested for validity in section *4.2 Survivorship bias* to make sure that it is not compromised by survivorship bias and does not exhibit abnormal returns as a result.

Prior research on the topic on other geographical areas has predominantly used a lengthier time period to allow for R&D investments to play out (Anagnostopoulou, 2008). Accordingly, the selected time period studied is 2013-2019. This will allow for direct comparisons to previous research and thus more thorough analysis of the possible relationship between expenditures in research and development and subsequent market returns in Sweden.

1.4 Thesis Structure

The thesis is structured in the following order:

Introduction: This section includes a background description of the thesis and the necessary information surrounding the topic and the aim as well as the limitations of the study.

Theoretical framework: This section includes a thorough description of research and development, containing its motives, potential profitability and its relation to accounting

standards. Additionally, the foundations for regression analysis are presented as well as Jensen's Alpha for detecting abnormal returns. Also, the research done by Fama and French regarding asset pricing are displayed.

Previous Research: The findings of previous research regarding the beneficial effects of R&D expenditures on stock returns are presented.

Data: The sampling process is described, and its reasoning is explained.

Methods and choice of methodology: This part describes our approach for the regression analysis, how the investigation has been conducted and our hypothesis. It also includes a section that discusses the ethical considerations of the research.

Empirical Results: The results of our calculations are presented in the form of tables.

Discussion & Conclusion: At the end of the thesis is a discussion of our findings in the previous chapter and a discussion on how the results of the regressions relate to our hypothesis. Finally, a conclusion is offered as well as suggestions for subsequent research.

2. Theoretical framework

2.1 IAS 38 - Intangible Assets

The International Financial Reporting Standards Foundation defines an intangible asset as, "An intangible asset is an identifiable non-monetary asset without physical substance"(IFRS, 2021). As such, it is generally hard to correctly valuate and is often accompanied by uncertainty. To combat this, expenditures for intangible assets are therefore ordinarily reported as a cost unless its cost can be reliably estimated and that the expenditure will likely yield future economic benefits. Investments in research and development are inherently uncertain and the likelihood of future economic benefits is as well. It is therefore generally recognised as an expenditure. However, if the R&D has advanced far enough into a developmental phase, future economic advantages are probable, and the expenditures can then be recognized as an intangible asset. This diverges from the U.S. GAAP where all expenditures are expensed immediately, regardless of stage of completion.

2.2 Categories of R&D

Basic Research

Basic research is experimental or theoretical work conducted principally to extract further information on the foundations of phenomena and recognizable facts, with no specific application or use in mind. As might be expected, with the definition of intangible assets in mind, this part of R&D frequently has more economic uncertainty as it is in the initial stages, it is customarily expensed directly.

Applied Research

The findings from the basic research are then used further to examine the phenomena again or something related to it. However, the fundamental difference between applied and basic research is applied research has a specific aim and is therefore more directed and conscious.

Experimental Development

Experimental development is to systematically utilize findings from basic and applied research to develop novel products, processes, systems or to substantially improve the current

condition of mentioned objects. Accordingly, if a company continuously explores possibilities to improve processes or products to maintain a competitive advantage it would fall into the category of experimental development. Moreover, there are typically lesser risks involved in this part of R&D and potential economic benefits are more likely, however, the potential gains are smaller.

2.3 Motives for investing in R&D

R&D is important for companies to continuously improve as well as sustaining their comparative advantages against competition. The underlying scope is to improve processes or products in order to reduce costs. Additionally, newly acquired knowledge can result in innovative products, possibly increasing the company's market share that way. Furthermore, previous research has implied that absorptive capacity increases with investments in R&D (Cohen & Levinthal, 1990). Absorptive capacity is defined as a company's ability to recognize the value of new information and to employ it to commercial ends. Moreover, the absorptive capacity is a function of the company's earlier knowledge on the matter. Therefore, consistent investments in R&D should increase the firm's capacity to adopt new information and employ it commercially. In this manner, the companies who invest in R&D may be more capable of embracing the findings of other companies' research.

There does exist a managerial incentive regarding how the investments in R&D are communicated in financial reports (Cazavan-Jeny & JeanJean, 2006). If the expenditures for R&D are capitalized instead of expensed, financial metrics are improved especially in the short term since the costs are pushed forward in time. Additionally, if capitalized the ensuing costs will be amortizations of the intangible asset which means it will not impact the EBITDA margin. Cazavan-Jeny and JeanJean's findings suggest that managers are not adequately capitalizing projects based on their probability of success, in contrast to the fundamental intention for its allowance. Moreover, the researchers found managers are either unable to appropriately gauge the R&D projects or that they simply utilize the regulation's flexibility to manipulate earnings.

2.3 Regression analysis

The intended purpose of a regression is to predict the value of a variable based on one or more independent variables (Sykes, 1993). A simple regression is one that includes only one explanatory variable, in our case the ratio of R&D expenses over market capitalization. Furthermore, a multiple regression is a more developed simple regression. The fundamental difference between the two is that the multiple regression studies more potential explanatory variables whereas the simple regression explores one. Consequently, a multiple regression becomes appropriate if the dependent variable cannot be explained simply by a single independent variable. Since this is likely the case with the returns of equity, evident by the published findings of Fama and French, a multiple regression seems suitable.

2.4 Fama & French (1992): Three Factor Model

In an article from 1992 Fama and French presented a model where they, through a cross sectional regression, had tested which variables were predictive of a stocks' future returns. Their published findings were:

Beta

Their findings were that the explanatory variable, beta, from the capital asset pricing model showed little correlation with a stocks' return. This has also been shown by other research such as Reiganum (1981) and Shapiro(1986). As this is the case, the study will not use solely beta and therefore not the CAPM-model to accurately predict a stock's future returns.

Market Capitalization

The market value of a company is indicative of the company's risk (Banz, 1981). Consequently, the CAPM is typically lacking as it does not take into consideration the size of the company. This is another key reason as to why the CAPM will not be used.

Book-to-Market

The book-to-market value of a company is its book value of equity divided by the market value of equity. Fama and French have identified a direct correlation between a company's book-to-market value and its subsequent returns. Furthermore, this is the primary explanatory variable in the three factor model.

Capital Structure

A company's usage of economic leverage maintains a positive relation with its expected return. This is predictable as heavily leveraged companies are more sensitive to shocks and naturally deliver more volatile earnings than their counterparts. The beneficial effect of leverage should be adequately captured by the company's beta according to CAPM, yet previous research has shown that including the variable helps predict a stocks' return (Bhandari, 1988).

Earnings/Price Ratio

The presented argument for including the E/P-ratio is that for a cross-section of returns, the E/P ratio detects unknown factors in the expected returns. Accordingly, the ratio is expected to be larger for riskier firms regardless of the unknown origins of possible risk.

2.5 Jensen's Alpha

Based on the Capital Asset Pricing Model (CAPM), Jensen's alpha is a tool for measuring the risk-adjusted returns of a portfolio or an individual security (Phouc, 2018). The reasoning is that the larger the alpha is, the better a security or portfolio has performed in relation to its expectations by the CAPM model. Its existence is well-documented by researchers like Otamendi et al.(2008) as well as many others. Accordingly, it is a crucial component in modern portfolio theory in order to gauge performance. It has often been used to evaluate the performance portfolios or fund managers. However, Jensen's alpha can be utilized to see whether a sample of stocks exhibit abnormal returns based on the same premises. This would mean that the sample has an statistically significant intercept, the alpha. Consequently, if the alpha is indistinguishable from zero the studied firms do not demonstrate atypical yields.

2.6 Efficient-market Hypothesis

The Efficient Market Hypothesis(EHM) is a concept brought on largely by Eugene Fama in 1970. At its strong form, it states that share prices fully reflect all available information. Also, a market with these characteristics is called an efficient market. Its more modest part, weak

form, is where information of past prices is not indicative of future ones and implies that investors cannot outperform the market using this information. Fama found empirical evidence to support the EHM which is why it has stood the test of time. Furthermore, the EHM is relevant to our thesis because if managers are required to judge the R&D projects chance of success as well as communicating this with the market, it means the market has access to more information. The capitalizing of R&D expenditures would signal improved performance of the firm and remove monopolistic access to information. Research has shown markets reacting to both managers choosing to expense and capitalize (Tami et al., 2009), indicating that it is useful information for investors. Consequently, it is possible that the more nuanced accounting standard contributes to a more efficient market.

3. Previous research

3.1 Chan, Lakonishok and Sougiannis (2002): The Stock Market Valuation of Research and Development Expenditures

Louis K. C. Chan, Josef Lakonishok and Theodore Sougiannis(2002) conduct research on whether stock prices accurately account for the value of the firm's intangible assets, specifically the value of the research and development. The accounting standards in the United States do not require firms' to disclose, in their financial statements, extensive information regarding the intangible assets and the research and development costs are expensed. According to their research, the average historical stock returns of firms are the same for firms conducting research and development and for those who are not. The authors suggest that when investors fail to consider the long term effects of the value of research and development to the standard measures of price-to-earnings and price-to-book ratios, there is a great risk for mispricing the value of the firm's stock.

3.2 Lev and Sougiannis (1996): The capitalization, amortization, and value-relevance of R&D

In their paper from 1996 Lev and Sougiannis aim to inquire whether there is a systematic mispricing of companies that invest more into R&D. As the US GAAP requires immediate expenditure of the R&D costs, Lev and Sougiannis produce a formula for capitalizing earlier years R&D expenditures. The US GAAP demands instantaneous expenditure of R&D as the Financial Accounting Standards Board(FASB) in 1974 presumed there was no relation between it and following benefits. However, with the emergence of new science-based industries such as software and biotechnology, companies in the US have continuously increased their investments in R&D. With this in mind, the assumed absence of a relationship between R&D and following benefits should be tested, argue the researchers. The reasoning of FASB was that problems of reliability as well as objectivity were too big of an audit risk. Thus, Lev and Sougiannis sought to address these issues. Besides assessing the financial performance of firms, they also tested the relationship between the company's R&D capital and its ensuing market performance. Their findings were that R&D had a favourable effect on the monthly returns and was statistically significant. Moreover, the effect of the R&D capital

was greater for firms with a lot of it. In the final analysis they state that their research plausibly suggests that either there is a systematic mispricing of R&D-intensive companies, or that the extra returns are an effect of increased risk for these firms.

3.3 Anagnostopoulou (2008): R&D expenses and firm valuation: a literature review

Seraina C. Anagnostopoulou (2008) conducts a meta-analysis of the literature findings on companies' R&D expenses and their following market return. The specific subject has been explored before, and the findings are supportive of a beneficial relationship between the two. A notable example is Sougiannis (1994), who found that the marginal benefit of a dollar spent on R&D typically meant a five dollar increase in market value through regression analysis, focusing on companies in the US. Furthermore, Sougannis suggests R&D investments have a direct and an indirect effect on the market value of firms. The direct effect is the markets' reaction to information about R&D expenses, and the indirect effect is the investments' effect on earnings. As the investments in R&D bear fruit and its benefits are visible in the firm's reported earnings, investors expect this effect to remain, under the assumption of sustained investments. In addition, the indirect effect is discovered to be greater than the direct effect, meaning the R&D expenses identified through earnings are more impactful than by themselves. Similar results have been found by Eberhart et. al(2004), when observing businesses with sharp increases in R&D investments. Others have employed numerous methods to adequately assess the market performance following R&D expenses like Tobin's Q or looking at advertising capital and lagged amounts of R&D.

3.4 Ferdaous and Rahman (2019): The effects of intangible assets on firm performance

In their article Feradaous and Rahman explore the relationship between intangible assets and firm performance on listed firms in Bangladesh. They perform a regression analysis for the financial performance of the studied companies as well as market-based performance and control for other potentially explanatory variables like size, leverage and asset turnover. Their

findings indicate were that intangible assets correlated positively with financial performance, meaning it typically raised earnings per share. However, the market based performance of the firms were worsened by the presence of intangible assets. As follows, this inevitably suggests that if a company in Bangladesh were to invest less in intangible assets its subsequent returns would typically improve. Feradaous and Rahman argue this might be the case in the Dhaka Stock Exchange due to three possible reasons. First, while the Bangladeshi economy is progressively improving on certain measures, its stock market is not efficient. Thus, the investors do not accurately value assets resulting in shares not trading at their fair value. The second possible reason, they argue, is that investors do not believe in the firm's ability to establish sustainable comparative advantages by investing in intangible assets. If this is the case then investors might consider R&D investments as they are reported in the income statement, as expenses which lowers their market value. Lastly, the third possible reason is information asymmetry. Investors might not receive enough necessary information about the context in which R&D expenses appear. The information asymmetry is greater with intangible assets as opposed to tangible and financial assets. This can be perceived as a possible source of risk, naturally resulting in investors undervaluing the company in question. As a result, the researchers believe there is a need for further research on intangible assets and market performance in less developed economies.

4. Data

4.1 The Sample

To conduct this study, data from the period between 2013 and 2019 will be utilized. There is a trade-off between lengths of the studied time period. On one hand the more extended time period represents more substantial evidence for the effect of investments in research and development, on the other hand it means reducing the sample size by removing the firms without an extensive history. This might skew the selected sample, as the data would consist of "surviving" companies, which arguably are more likely to produce a conclusion of consistent undervaluation. In order to combat this potential problem, we will investigate if our sample exhibits abnormal returns.

When sampling, all companies who fulfil the following criteria were observed:

• The company has to have been public for at least 8 years. The reasoning behind this is to acquire a substantial basis for our analysis.
• It has to be a company listed on the Swedish Stock Exchanges.
• The company has to report R&D expenditures.

With these specific criteria a sufficient sample size of 61 public firms are gathered. We believe this is an acceptable number of companies to perform meaningful studies.

To collect the necessary data, the comprehensive database CapitalIQ was utilized. The database is provided by S&P Global which is one of the world's largest providers of financial data(Investopedia, 2021). Moreover, the following financial figures were collected:

Figure	**Excel Formula**
Share Price	=@CIQ(IDENTIFIER, "IQ_LASTSALEPRICE", DATE)
Market Cap	=@CIQ(IDENTIFIER, "IQ_MARKETCAP", DATE)

Total Equity	=@CIQ(IDENTIFIER, "IQ_TOTAL_EQUITY", "FY"& YEAR)
Total Assets	=@CIQ(IDENTIFIER, "IQ_TOTAL_EQUITY", "FY"& YEAR)
2-Year-Beta	=@CIQ(IDENTIFIER, "IQ_BETA_2YR", DATE)

4.2 Descriptive Statistics

This part intends to give an outline of the data that has been utilized in the regression analysis. In the first section, general information in regards to the explanatory variables is displayed. Furthermore, the latter part discloses the equivalent statistics about the different portfolios.

Table 4.2 - Descriptive statistics for the overall sample

Descriptive Statistic	Beta	Market Cap	Leverage	Earnings /Price	-Earnings/Price Dummy	R&D/Market Cap
Mean	0.73	33924	1.18	0.03	0.28	0.07
Median	0.75	2574	0.86	0.03	0.00	0.02
Maximum	2.58	435589	15.14	1.64	1.00	5.15
Minimum	-2.36	6	0.10	0.00	0.00	0.00
Std. Dev.	0.51	70585	1.41	0.07	0.45	0.22

All the variables have 4453 observations

Table 4.3 - Descriptive statistics for the three portfolios

High	Beta	Market Cap	Leverage	Earnings/Price	-Earnings/Price Dummy	R&D/Market Cap
Mean	0.71	29343	1.69	0.03	0.51	0.16
Median	0.72	742	1.22	0.00	1.00	0.08
Maximum	2.36	349959	15.14	1.64	1.00	5.15
Minimum	-1.77	26	0.13	0.00	0.00	0.00[a]
Std. Deviation	0.56	73711	1.78	0.10	0.50	0.35
Medium	Beta	Market Cap	Leverage	Earnings/Price	-Earnings/Price Dummy	R&D/Market Cap
Mean	0.63	34391	1.01	0.03	0.24	0.03
Median	0.65	1741	0.88	0.03	0.00	0.02
Maximum	2.58	254701	4.33	0.19	1.00	0.55
Minimum	-2.36	6	0.10	0.00	0.00	0.00[a]
Std. Deviation	0.53	58922	0.69	0.03	0.43	0.05
Low	Beta	Market Cap	Leverage	Earnings/Price	-Earnings/Price Dummy	R&D/Market Cap
Mean	0.85	38267	0.82	0.04	0.09	0.01
Median	0.86	5921	0.54	0.04	0.00	0.01
Maximum	2.05	435589	13.98	1.02	1.00	0.16
Minimum	-0.33	62	0.12	0.00	0.00	0.00[a]
Std. Deviation	0.40	77361	1.36	0.06	0.29	0.02

[a]High: 0.0026, Medium:0.0016, Low:0.0009

4.3 Survivorship Bias

As mentioned earlier, observing companies with continued operations for 8 years could imply a survivorship bias where only companies with successful R&D investments are included. To see whether this is the case, we will use the Jensen's Alpha to explore potential abnormal returns. We have chosen to use OMXSPI to represent the overall market and the 3 month Swedish Treasury bill for the risk-free rate. Thus, the following formula is used:

$$R_{S,\,t} - R_{F,\,t} = \alpha + \beta\left(R_{M,\,t} - R_{F,\,t}\right) + e_t$$

Where the variables are

$R_{S,\,t}$ = Weighted return of the companies sampled in the month t

$R_{M,\,t}$ = Market return of OMSXPI during the month t

$R_{F,\,t}$ = The risk-free return, the 3-month Swedish Treasury bill in month t

The regression was run for 73 months between the period 2014-2020. The estimated alpha was 0.004 with a t-value of 1.70 and thus indistinguishable from zero as well as statistically insignificant. Furthermore, the beta was estimated at 0.997 with a t-value of 15.92, and therefore statistically significant. Also, the regression had an adjusted R^2 of 0.78. With this in mind, it is possible to conclude that the findings of our report are unlikely to be a result of a survivorship bias.

5. Methods and choice of methodology

5.1 Hypothesis

The ratio of R&D-expenses/Market Capitalization will be examined to observe its relationship with the return of the firms' stock. We have selected market capitalization in conjunction with the EHM but will perform the analysis with financial metrics as well. Furthermore, the companies will be divided into three portfolios based on their R&D/Market Capitalization. As follows, there will be a "low", "medium" and "high" portfolio(See Appendix). The low, medium and high portfolios refer to the intensity of the R&D expenditure measured by R&D/Market capitalization. The purpose of low, medium or high in reference to the size or market capitalization of the company. With that in mind, there is still a risk that there are outliers and extreme values in the sample. That possibility, however, is taken into account in *4.2 Survivorship bias* where a regression is run to test the validity of the sample and it turns out that it can be concluded that the results of the regressions in *6. Empirical results* are unlikely to be a result of survivorship bias. After the companies are divided into portfolios, the portfolios' risk-adjusted returns will be calculated and then compared to each other. If the risk-adjusted returns of the portfolios should be the same, but if they are not then the market systematically misvalues companies' investments in R&D. Considering the earlier findings of previous research, we believe we will find a positive relationship between a firm's investments in R&D and its ensuing market returns. However, since the accounting standards differ the effect is expected to be smaller. The market data will be gathered from CapitalIQ and then a simple linear regression and a multiple regression will be conducted in Excel in order to test the following hypothesis:

H_0=*The risk-adjusted return of public R&D-intensive companies is equal to the market return.*

H_1=*The risk-adjusted return of public R&D-intensive companies is not equal to the market return.*

5.2 Regression Analysis

In order to evaluate our hypothesis, we conduct a thorough regression analysis. Moreover, historical data from the period 2013-2019 will be studied where financial data will be collected on an annual basis as it is reported in such a manner while returns will be collected on a monthly basis. In order to risk-adjust the returns, the previously presented factors are included to prevent the returns from being skewed from other potential sources of risk. Thus, the regression includes size risk as well as value risk factors, besides the market risk factor, beta. Later we will first execute a simple regression with monthly returns as the dependable variable and the R&D/Market Cap as the explanatory variable. However, we will also conduct multiple regressions to properly examine if R&D/Market Cap is significant while regressing against numerous independent variables.

The regression formulas used are:

(1) $R_i=\alpha_i+\beta_{\ln(R\&D/Market\ Cap)}+\varepsilon_i$

(2) $R_i=\alpha_i+\beta_{Beta}+\beta_{\ln(Market\ Cap)}+\beta_{\ln(Book-to-Market)}+\beta_{\ln(Leverage)}+\beta_{(E/P)}+\beta_{(-E/P\ dummy)}+\beta_{\ln(R\&D/Market\ Cap)}+\varepsilon_i$

The practical reasoning as to why some of the variables are logarithmic is due to logarithmic values more reliably captures the effects of independent variables on the dependent variable. Another positive consequence is it dampens the effect of extreme values on the dataset.

Our error term is partly an effect of idiosyncratic events for the firm i.e. one of the firm's factories burns down or the employees strike would cause variation in the monthly return regardless of the investments made in R&D or any of the other right hand explanatory variables. The occurrence of systemic shocks to the overall market, for instance pandemics, will also affect our error term.

5.3 Calculations of the variables

We base our method for calculating the variables on the Fama-French Three Factor Model for the potential sources of risk. They are computed as follows:

Returns: The monthly stock returns of the firm *i*, starting at the 4th month after the end of the firm's fiscal year in order to allow for disclosure of the financial reports.

Beta: A representation of how the company's share price moves in relation to the overall market. Much like previous research, a 24 month beta is used and which in our case is collected through CapitalIQ. CapitalIQ uses MSCI EAFE to represent the general stock market.

Market Capitalization: It is defined as the share price times the number of outstanding shares. This variable can be collected through the database CapitalIQ. Through its inclusion the monthly return is altered with regards to size risk.

Book-To-Market: The variable is calculated as the value of equity divided by the firm's market capitalization at the end of the year. This variable represents the value risk factor and adjusts the return for it.

Leverage: The ratio between the firm's total assets divided by its total equity at the end of the year.

Research & Development/Market Capitalization: This variable embodies the study's primary interest as it represents the companies' investments on R&D. Since this is financial data and reported annually the ratio is calculated on an annual basis. Therefore, it is the R&D expenditures divided by the value of equity at the end of the year. However, in their research Lev and Sougiannis have computed an estimation of the R&D-capital through and employed this as the variable for firms investments in R&D. Nevertheless, our thesis does not aim to prove reliability or objectivity in estimations of R&D with regards to accounting standards but its relationship with market returns. As follows, this study will examine the reported R&D expenditure as it is more accessible as well as straightforward.

Earnings/Price: The ratio of the earnings of the firm *i*, at the end of their fiscal year divided by the market price of equity for firm *i*. If the firm's earnings are negative this variable is set to zero.

-*Earnings/Price dummy*: If the earnings of firm *i* are negative, this variable is set equal to 1 and if not it is set equal to 0.

5.4 Ethical Considerations

There are no significant ethical considerations regarding the data in itself, seeing as our thesis is of quantitative nature. However, the integrity of our selected database as well as its independence has been considered. We identify no conflicts of interest between S&P Global and the stock markets they report about. For the data regarding the Swedish 3-month treasury bill, it has been retrieved from the Swedish Central Bank, which we deem reliable.

6. Empirical Results

6.1 Simple Linear Regression

As a first step a simple regression is performed to test the variable R&D/Market Cap separately. This is done in order to gauge its significance in relation to the returns of firms without the effect of the other variables. The independent variable R&D/Market Cap is logged in the simple regression to adjust for the outliers in the sample and to make sure that the effect of the variable is captured in a reliable way. In the tables below our findings from the simple linear regressions are presented. As shown by table 5.1 the RD/M variable is statistically significant by itself at the 0.01 level. The coefficient for the explanatory variable of 0.0402 suggests that the average annualized effect of RD/M is an 4.81% increase in annual return. Consequently, the results strongly indicate that there is a positive relationship between the RD/M and subsequent market returns, at least when tested by a simple linear regression. This is in line with the expectations of a more well-developed market such as the Swedish stock market. However, it should be noted that the simple linear regression might include an omitted variable bias as there are presumably other factors that explain monthly returns besides the R&D expenditures.

Table 6.1 - Simple Linear Cross-Sectional Regression

	Coefficient	Standard Error	t-statistic	p-value
Constant	0.1628	0.0532	3.06	0.003
ln(RD/M)	0.0402	0.0147	2.73	0.008

6.2 Multiple Regression

For the log-transformed explanatory variables, a 1% change in the variable results, on average, in an increase/decrease in the monthly return equal to its estimated coefficient. To illustrate, if the ratio RD/M increased by 1% for a firm in the "Low" portfolio, it would lead to a 0.0172 percentage unit increase of the monthly return of that firm. Likewise, for the other explanatory variables, the increase of one unit would typically increase or decrease the mean of the monthly returns equivalent to its coefficient.

As table 6.2 presents the estimated coefficient is positive with an average across the three portfolios of 0.0126. However, the coefficient RD/M is statistically significant for the "Medium" and "Low" portfolios but not in the "High". In addition, the estimated effect is more considerable for the firms with a lower RD/M-intensity.

The independent variables accounting for market, size and value risk are not statistically significant in any of the portfolios. Neither is the dummy for the companies reporting a loss. Compared to the findings of Fama & French, where they found the variables book-to-market and market size to be significant, there is little conformity between our results.

If financial metrics are used instead of market data to evaluate the effect of R&D, the regressions return similar results. The variable still is not significant for the High portfolio, but is for the Medium and Low. Also, the coefficients as well as the t-statistics are practically identical regardless which metric is used.

Table 6.2

R&D-Expenditures and subsequent market returns

Coefficient estimates for cross-sectional regressions of monthly returns on log-transformed variables. Stock returns are calculated for 12 months starting at the fourth month after the end of the companies' fiscal year. The coefficients are calculated over 73 regressions for the years 2013-2019. T-statistics are reported in parentheses, and emboldened if statistically significant at the 0.05 level.

Portfolio[a]	Intercept	Beta	Market Cap	Book-to-Market	Leverage	E/P	E(-)/P Dummy	RD/M	Adjusted R^2
High	0.0260	-0.0162	0.0003	0.0010	-0.0119	-0.0266	-0.0031	0.0047	0.0027
	(0.87)	(-1.79)	(0.14)	(0.19)	**(-2.26)**	(-0.51)	(-0.21)	(0.62)[b]	
Medium	0.0693	-0.0005	0.0012	0.0063	-0.0010	0.0253	-0.0133	0.0157	0.0077
	(2.75)	(-0.07)	(0.64)	(1.09)	(-0.21)	(0.15)	(-1.07)	**(3.15)[b]**	
Low	0.1092	-0.0154	0.0007	-0.0036	0.0024	-0.1194	0.0158	0.0172	0.0244
	(4.46)	(-1.63)	(0.29)	(-0.99)	(0.56)	**(-2.00)**	(1.2)	**(4.07)[b]**	

[a] Portfolios are made based on their R&D/Market Cap ratio, “High” representing 21/61 firms, “Medium” representing 20 firms and “Low” representing 20 firms. .

[b]When calculated over financial metrics instead of market values, the coefficients and t-statistics for RD/Total Assets for the portfolios are: High: 0.0048 (0.65), Medium: 0.0159 **(3.28)**, Low: 0.0171 **(4.16)**

Regression: $R_i=\alpha_i+\beta_{Beta}+\beta_{ln(Market\ Cap)}+\beta_{ln(Book-to-Market)}+\beta_{ln(Leverage)}+\beta_{(E/P)}+\beta_{(-E/P\ dummy)}+\beta_{ln(R\&D/Market\ Cap)}+\varepsilon_i$

7. Discussion and Conclusion

The results are to some extent varied although heavily favouring the existence of a positive relationship between the market performance of and their R&D investments. Accordingly, the average annualized effect (average RD/M multiplied by its average coefficient over the portfolios) is 1.48%, which represents our estimate for the incorrect pricing, investor underreaction or the risk premium. The estimate is a positive relationship albeit smaller than earlier research has found, comparing it to 4.52% (Lev & Sougiannis, 1996) or 3.66% (Eberhart et. al, 2004). Still, since the U.S. regulations differ from European ones as Swedish companies may capitalize part of their R&D expenditure the finding is reasonable and within our expectations. Because of the incentive for managers to capitalize R&D expenditure, as it improves financial metrics, it is reasonable that the costs become smaller as a consequence of the regulations allowing capitalization.

Why the estimated coefficient is more substantial for the companies with a lower R&D expenditure relative to the market value of their equity is uncertain. On average, the businesses in the “High” portfolio are smaller than those in the other portfolios. This could explain why the estimated coefficient is smaller for the firms in the "High” portfolio. If an assumption that larger companies in general have existed for a longer time is made, its R&D could benefit from its lengthier history. This is because of the concept of absorptive capacity where companies get more efficient over time at utilizing new information commercially. Conceivably, larger firms maintain a more developed approach to R&D, leading to a lessened need for sizable investments, which explains the inverse relationship between size and estimated coefficient. Another potential reason is that the companies in the “Low” & “Medium” portfolios may have come further in their R&D, or alternatively that the companies in the “High” are at an earlier stage. If this is the case, these companies capitalize more of their expenditures, resulting in a lower RD/M ratio. Consequently, the companies who have completed more of their R&D are less risky, due to the probability of future positive returns increases which in turn leads to a more valuable company. Another reasonable factor is that these companies’ financial metrics ratios are, all things equal, better because they have lower costs. Moreover, it could be that the firms experience a decreasing marginal benefit from expanded investments in R&D.

Considering the fact that the average annual effect is smaller in Sweden than in other countries suggests it would be a matter of incorrect pricing and not a proxy for an additional risk factor. If it were a risk premium, the effects ought to be more similar. The possible alternative would be that Swedish companies' investments in R&D are less risky than in firms in the USA, which seems unlikely. The effect being larger for the companies with smaller RD/M ratios is also in contrast with the idea of a risk premium. Otherwise, the effects should be the largest for the firms investing the most. In addition, a supplementary argument is that the beneficial effect is smaller where the market has access to more information (since the company makes an assessment of how far it has come in R&D when producing financial reports) suggesting markets incorrectly value investments in R&D. However, since a part of the expenditures get capitalized, it is difficult to draw a conclusion as to whether the effect is smaller due to partly capitalizing expenses, investors having access to more information or a combination of the two.

We believe that IFRS' way of valuing R&D investments is more appropriate seeing as the data indicates the investment is likely to entail financial benefits for the company, at least based on its share price development. Based on our regression, it is reasonable to capitalize a part of the R&D expenditures, because it seems to fulfil the requirements of reliability and probability of future benefits. The accounting standards employed in Sweden require companies to make a judgement regarding the probability of economic benefits of its R&D. As follows, this assessment indirectly communicates the investment's stage of completion, on the grounds that the risk decreases along with its completion. Moreover, it is possible to argue for the conclusion that the market becomes more efficient as a result of information. If investors are more informed of where in the R&D process a firm is, they should be able to more accurately assess the riskiness of said firm.

To conclude, our findings suggest that there is empirical evidence to support the positive relationship between R&D investment and subsequent market returns. It is however, a smaller effect than earlier research has established and the reasons for it are rather ambiguous. The potential explanations are contrasting regulations giving rise to either a smaller RD/M ratio or a more efficient market due to investors having access to more information. Also, our results indicate that the abnormal returns are not a consequence of an additional risk premium but rather a mispricing by the market.

As the regulations US GAAP & IFRS differ radically, it would be intriguing to examine R&D expenditure and the year-on-year percentage change in R&D capital to see if the distribution between capitalized investments and expensed is indicative of equity returns. We hope this topic will be addressed in the future research ahead.

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Appendix

The appendix includes the companies in the portfolios used in the regression, which portfolio they are included in and what industry they are a part of.

Name of Company:	**Type of Company or Industry:**	**Portfolio:**
Telefonaktiebolaget LM Ericsson	Telecommunications	High
AB Volvo	Car manufacturer	High
Autoliv, Inc.	Automotive safety supplier	High
Saab AB	Military defense & civil security	High
Orexo AB	Pharmaceutical industry	High
BioInvent International AB	Pharmaceutical industry	High
RaySearch Laboratories AB	Pharmaceutical industry	High
Haldex AB	Manufacturing industry group	High
Eniro AB	Digital marketing & search engine	High
Net Insight AB	Network solutions	High
Precise Biometrics AB	Identification software company	High
Neonode Inc.	Optical sensing solutions	High
TradeDoubler AB	Digital marketing	High
Active Biotech AB	Biotech	High

Obducat AB	Developer of micro- & nano technology	High
MultiQ International AB	LCD technology specialists	High
Concejo AB	Investment company	High
Studsvik AB	Technical services for the nuclear power industry	High
Moberg Pharma AB	Pharmaceutical industry	High
Ortivus AB	Medtech	High
Anoto Group AB	Technology solutions	High
Hexagon AB	Technology	Medium
ASSA ABLOY AB	Manufacturing & services	Medium
Sandvik AB	Industry	Medium
Swedish Orphan Biovitrum AB	Pharmaceutical industry	Medium
Elekta AB	Pharmaceutical industry	Medium
Alfa Laval AB	Energy, environment, food & the marine industry	Medium
Getinge AB	Medtech	Medium
Mycronic AB	Partner to electronics- & displaymanufactururs	Medium
Enea AB	Software company	Medium
VBG Group AB	Industry manufacturing group	Medium

Boule Diagnostics AB	Diagnostics	Medium
Kancera AB	Pharmaceutical company	Medium
Sensys Gatso Group AB	Traffic safety solutions	Medium
Concentric AB	Pump manufacturer	Medium
Elos Medtech AB	Medtech	Medium
MidWay Holding AB	Automotive construction machinery, business solutions & communications equipment	Medium
SinterCast AB	Process control technology	Medium
Svedbergs i Dalstorp AB	Bathroom manufacturer	Medium
Star Vault AB	Game developer	Medium
SensoDetect Aktiebolag	Diagnostics	Medium
Atlas Copco AB	Industry	Low
Boliden AB	Mining- & smelting plants	Low
Trelleborg AB	Rubber & plastic solutions	Low
Investment AB Latour	Investment company	Low
Telia Company AB	Telecommunications	Low
Indutrade AB	Technology & industrial business group	Low
HMS Networks AB	Information technology	Low
BioGaia AB	Biotech	Low
HEXPOL AB	Product- & Application	Low

	Specialist	
Fingerprint Cards AB	Safety technology	Low
Vitrolife AB	Medtech	Low
Biotage AB	Biotech	Low
Nederman Holding AB	Industrial air filtration	Low
Lindab International AB	Products & solutions for steel industry	Low
Pricer AB	In-store, digital shelf-edge solutions	Low
CellaVision AB	Medtech	Low
Diamyd Medical AB	Pharmaceutical industry	Low
Duni AB	Kitchen equipment	Low
Skåne-möllan AB	Mill developing flower & cereal products	Low
Invisio AB	Technology solutions	Low