University of Economics, Prague
Faculty of Business Administration
The International Management Programme

Diploma Thesis:

Pharmaceutical Industry - R&D Investment: Link to Profitability & Market Value

Author:
Bc. Martin Vlasatý

Diploma Thesis Supervisor:
doc. Ing. Inka Neumaierová, CSc.

Declaration of Authenticity

I hereby declare that the Master's Thesis presented herein is my own work, or fully and specifically acknowledged wherever adapted from other sources. This work has not been published or submitted elsewhere for the requirement of a degree programme.

In Prague on December, 10th 2012

Acknowledgments

I hereby wish to express my appreciation and gratitude to the supervisor of this Master's Thesis, doc. Ing. Inka Neumaierová, CSc., for her great support, helpful professional advices, and assistance.

Title of the Master's Thesis:

Pharmaceutical Industry - R&D Investment: Link to Profitability & Market Value

Abstract:

The aim of this thesis is to examine whether there is a positive relationship between pharmaceutical firms' investments in research and development (R&D) and their profitability as well as market value. This is achieved by employing the simple linear regression analysis, based on sample data gathered over five-year period per each of the fifteen selected leading research-based pharmaceutical companies.

The results show that there is statistically significant but relatively weak linear association between level of R&D expenditures and firms' profitability and market value, if measured by Return on Sales, Return on Assets, or Price-to-Sales ratios. Nevertheless, no significant link was identified in case of level of R&D investments and Return on Equity, or Price-to-Book Value ratio. Thus, overall, based on the sample data analyzed, it can be concluded that there is a very limited potential for boosting research-based pharmaceutical firm's profitability as well as market value solely by increasing its R&D expenditures.

Key words:
R&D; profitability; market value; regression; pharmaceutical industry

Content:

1 Introduction

In 2010, according to Global Innovation 1000 study, approximately USD 142 billion was invested into research and development (R&D) by solely twenty companies – the biggest R&D spenders worldwide. Moreover, sum exceeding USD 9 billion was spent on research and development by each of the top three ranked companies (Booz & Company, 2011). However, the question that arises is whether these enormous R&D budgets are simply worth the investment.

The aim of this thesis is to examine, if those firms who spend more funds on R&D become more profitable, as well as more valuable from investors' perspective. More specifically, this R&D - profitability and market value link will be examined in the context of the pharmaceutical industry. Therefore the research question is whether greater spending on research and development from the side of research-based pharmaceutical companies leads to higher profitability as well as market value.

The pharmaceutical sector was chosen due the following major reasons. Firstly, pharmaceutical companies are constantly ranked among top R&D spenders globally. For instance, in 2010, four out of top five slots were held by pharmaceutical firms. Roche, Pfizer, Novartis and Merck, these are pharmaceutical companies with annual R&D budgets that exceed well known research and development spenders such as Toyota, or Samsung (Booz & Company, 2011). The underlying logic behind such high R&D expenses from the side of pharmaceutical companies is to some extent straight forward. As concluded in the report of Deutsche Bank (2003, p.31) "R&D is the lifeblood of the industry. It is only through innovation and the launch of new and effective forms of medicine that the pharmaceutical industry can continue to grow."

Secondly, there has been an ongoing debate regarding the linkage existence between R&D expenses and profitability, or market value, specifically in the context of the pharmaceutical industry. There are authors, such as Hajiheydari, Dastgir and Soltani (2011) or Hanel and St-Pierre (2002), who argue that there is a positive link between the R&D spending and firm's performance. Nevertheless, on the other side, other authors as Koku (2010) conclude that there is no relationship between firms' performance and annual R&D budgets. Therefore, despite the fact that this paper does have the ambition to compete with the extensive researches done or complex analytical models employed by the above mentioned authors in order to examine the linkage in question, ultimately, it will attempt to provide some degree of clarity and simplicity regarding this matter.

Last but not least, the leading companies in the pharmaceutical sector are in majority of cases publically traded, which means that the data needed to be able to examine R&D investment – profitability or market value link are relatively easily accessible.

Regarding the structure of this thesis, firstly, in the theoretical part, the general features of the pharmaceutical industry will be provided. More specifically, industry overview and its prospects will be presented, followed by the description of growth drivers as well as challenges. After that, the research and development process will be examined. Another part of the theoretical section is dedicated to the literature review. Diverse authors' perspectives regarding the linkage between

R&D investments and profitability, or alternatively market value, will be outlined. Finally, the analytical tools applied in the practical part for such link examination will be introduced. These analytical tools comprise the harmonised measure for R&D expenses, profitability and market value ratios, and last but not least, the regression analysis model which will be employed for the assessment of the linkage in question.

At the beginning of the practical part, the selected sample of companies, whose data will serve as a source for the regression analysis between the level of R&D investment and profitability as well as market value, will be introduced. Afterwards, the regression analysis outputs will be presented as well as interpreted. This means that the research question, which is whether those firms who spend more funds on R&D become more profitable, as well as more valuable from investors' perspective, will be addressed. After that, major limitations of the analysis, together with the potentials for further research of the analysis will be outlined. Ultimately, the conclusion will recapitulate the major findings of this thesis.

2 Theoretical Part

As the research problem requires a fundamental knowledge of the pharmaceutical industry, firstly, the overview as well as specifics of this sector, including among others the characteristic features of R&D, will be presented. Secondly, the literature review of the matter in question – the link between research and development expenses and profitability, or alternatively market value will follow. Thirdly, the tools necessary for the purpose of this link's analysis will be provided.

2.1 Pharmaceutical Industry

In this section, the general overview of the industry, together with the pharmaceutical future prospects will be presented. This will be followed by the growth drivers and challenges identification. Finally, the specifics of research and development will be portrayed.

2.1.1 Overview & Prospects

Human endeavour to defeat diverse kinds of diseases and thus improve overall quality of life has made the pharmaceutical industry one of the largest global businesses. Driven by its ability to innovate, the industry has grown significantly over past decades, as new medicines have increased average life expectancy and as governments have strived to improve the health and quality of life of their citizens in general. As a result, nowadays, people are living longer, healthier and more productive lives, thanks to, among others, the efforts of research-based pharmaceutical and biotechnology companies in discovering new medicines to prevent, cure and treat diseases (Deutsche Bank, 2003).

It is estimated that in 2011, that the total pharmaceutical industry revenues reached USD 839 billion, which is 4.5% increase compared to the previous year. In terms of sales, the biggest market remained the US, representing 38.1% of global prescription pharmaceutical sales, followed by Western European market, accounting for 24.3% (IMS Health cited in AstraZeneca, 2012). More detailed overview of the market and its subdivision on US, Western European, Established Rest of World, and Emerging Rest of Wold is provided below. Exact definitions of these markets can be found in the Appendix.

Exhibit 1: World Pharmaceutical Market - Sales ($bn)

World Sales ($bn)

US Sales ($bn)

Western Europe Sales ($bn)

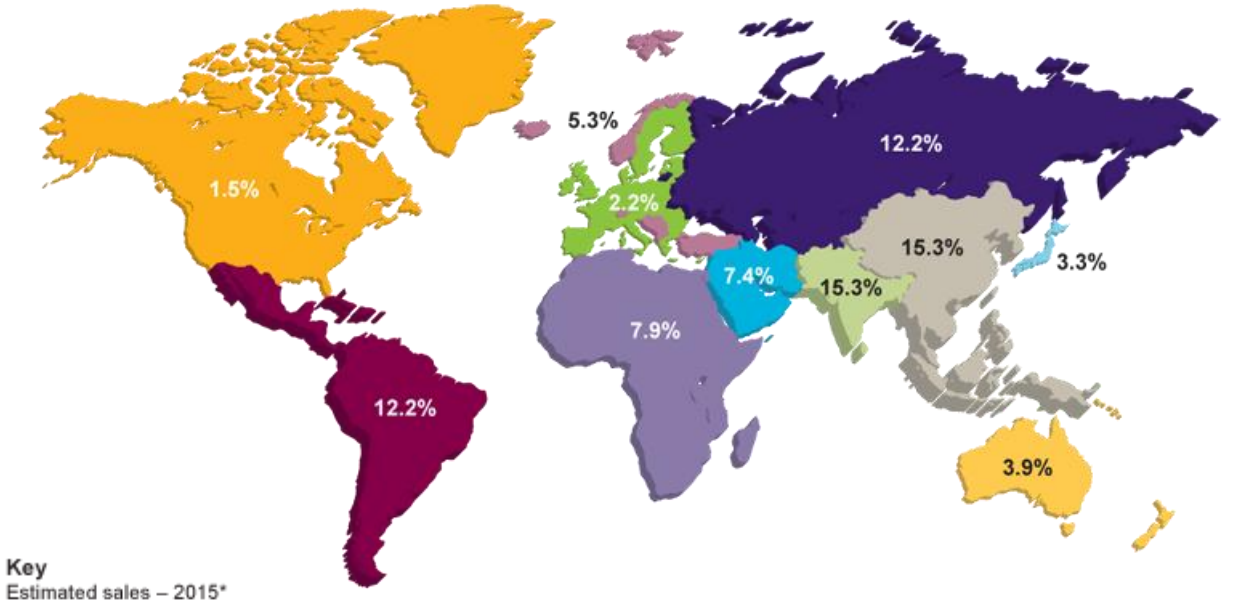
Established Rest of World Sales ($bn)

Emerging Rest of World Sales ($bn)

Source: IMS Health (2011 cited in AstraZeneca, 2012, p.16)

As shown above, the emerging markets experienced the highest growth rate in terms of total global prescription pharmaceutical sales. On the other hand, established markets' growth rates were in low single-digit range. It is believed that this trend will remain unchanged in the upcoming years, as shown in the following exhibit.

Exhibit 2: Estimated Pharmaceutical Market Growth (2010 - 2015)



Source: IMS Health (2011 cited in AstraZeneca, 2012, p.17)

They key to growth, however, is associated with the ability of companies to bring new innovative pharmaceutical products to the marketplace. This is especially valid in the context of research-based drug producers. Therefore, it is not surprising that pharmaceutical companies invest heavily into research and development (R&D) to enhance the chances of new drugs' discovery and subsequent launch to the market. According to '2011 Global Innovation 1000 study' completed by Booz & Company (2011), the world's top three biggest spenders in terms of absolute R&D investments were Roche, Pfizer, and Novartis - three multinational pharmaceutical companies. It is worth emphasizing that total R&D expenses of each of these three companies exceeded research and development budgets of corporations such as Microsoft or Toyota.

Exhibit 3: Global Top 20 R&D Spenders

Rank		Company	R&D Spending			Headquarters Location	Industry
2010	2009		2010, $US Millions	Change from 2009	As a % of Sales		
1	1	Roche Holding	$9,646	1.5%	21.1%	Europe	Healthcare
2	5	Pfizer	$9,413	20.0%	13.9%	North America	Healthcare
3	6	Novartis	$9,070	21.4%	17.9%	Europe	Healthcare
4	2	Microsoft	$8,714	–3.3%	14.0%	North America	Software and Internet
5	14	Merck	$8,591	53.0%	18.7%	North America	Healthcare
6	4	Toyota	$8,546	0.7%	3.9%	Asia	Auto
7	10	Samsung	$7,873	23.2%	5.9%	Asia	Computing and Electronics
8	3	Nokia	$7,778	–0.8%	13.8%	Europe	Computing and Electronics
9	11	General Motors	$6,962	16.0%	5.1%	North America	Auto
10	7	Johnson & Johnson	$6,844	–2.0%	11.1%	North America	Healthcare
11	13	Intel	$6,576	16.3%	15.1%	North America	Computing and Electronics
12	18	Panasonic	$6,176	10.7%	6.1%	Asia	Computing and Electronics
13	9	GlaxoSmithKline	$6,127	0.3%	14.0%	Europe	Healthcare
14	15	Volkswagen	$6,089	19.4%	3.6%	Europe	Auto
15	12	IBM	$6,026	3.5%	6.0%	North America	Computing and Electronics
16	8	Sanofi-Aventis	$5,838	–4.0%	14.5%	Europe	Healthcare
17	19	Honda	$5,704	5.2%	5.5%	Asia	Auto
18	22	AstraZeneca	$5,318	20.6%	16.0%	Europe	Healthcare
19	17	Cisco Systems	$5,273	1.3%	13.2%	North America	Computing and Electronics
20	16	Siemens	$5,217	–1.4%	5.1%	Europe	Industrials
		TOP 20 TOTAL:	$141,781	10.1% Avg.	11.2% Avg.		

Source: Booz & Company (2011, p.7)

As R&D represents a key element of this thesis, it is further elaborated in the chapter *2.1.4 Research and Development*.

Another characteristic feature of the pharmaceutical sector is also relatively high degree of M&A activity. For instance in 2010, there were 548 deals completed, valued at USD 51.5 billion (IMAP, 2011). More detailed overview based on geographic area of these transactions is provided below.

Exhibit 4: M&A Activities in 2010 at a Glance

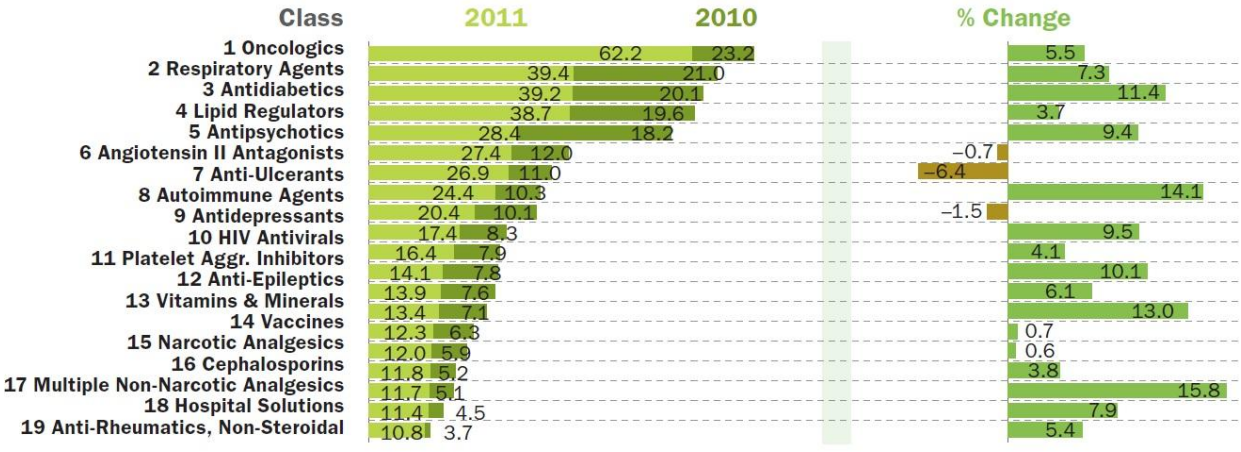
	US	Europe	Japan	China	Latin America	RoW	Total
Undisclosed Deals	47	79	16	26	7	64	**239**
Up to 20 Million USD	21	24	6	58	2	55	**166**
20 to 50 Million USD	13	10	2	13	5	17	**60**
50 to 100 Million USD	11	7	2	3	2	4	**29**
100 to 250 Million USD	10	3	0	2	1	4	**20**
250 to 500 Million USD	4	5	1	2	1	0	**13**
Above 500 Million USD	8	6	0	1	1	5	**21**
Total	**114**	**134**	**27**	**105**	**19**	**149**	**548**

Source: Thomson M&A database cited at IMAP (2011, p.2)

It is also expected that the consolidation trend will continue to transform the market. The mergers and acquisitions will enable companies not only to consolidate their core businesses, but also to get access to new areas of growth. Moreover, with low levels of interest rates and relatively high degree of cash on accounts of the market leaders, M&A activities are bound to further growth in near future (IMAP, 2011).

Last but not least, the most significant therapeutic classes in global scale will be outlined. These are dominated by oncologics, accounting for approximately USD 62.2 billion in terms of global spending in 2010. The oncologics is followed by respiratory agents, and antidiabetics as shown in the following exhibit (Clinton and Cacciotti, 2012).

Exhibit 5: Top Global Therapeutic Classes by Spending (in USD billions)



Source: IMS Health, cited in Clinton and Cacciotti (2012, p.25)

All in all, this section has provided a brief overview of the pharmaceutical industry and its future prospects. Firstly, the market value based on worldwide sales was discussed, followed by the predicted future growth of the sector. Afterwards, the M&A activity within the industry was

outlined. Finally, the listing of most important therapeutic classes by total global spending was provided.

Next, the growth drivers as well as major challenges in the context of pharmaceutical industry will be examined.

2.1.2 Growth Drivers

The above pointed out expected growth of the pharmaceutical industry is associated mainly with the following key drivers (AstraZeneca, 2012, p.15):

- Expanding patient populations;
- Unmet medical needs;
- Advances in science and technology.

Regarding the expanding patient populations, it is believed that the total world population will reach 9 billion by 2050, from approximately 7 billion in 2011. What is more, the number of individuals who can access healthcare continues to rise, especially among the elderly people. In a global scale, it is predicted that the number of people over 65 years old will be almost one billion, which is double of what it was in 2005 (AstraZeneca, 2012).

As outlined in Exhibit 2, the overall pharmaceutical market is expected to grow in the upcoming years. It is argued that significant portion of this growth will come from 17 so-called 'pharmerging' markets, where sales are foreseen to grow by double-digit figures. These dynamic, high-potential markets offer immense opportunities for the industry as a whole. There is no doubt that the major part of the growth opportunities is driven by China – the world's third biggest market in terms of pharmaceutical sales (IMAP, 2011). The incremental pharmaceutical market growth between 2009 and 2013 in predicted to reach more than USD 40 billion, as shown below.

Exhibit 6: List of Pharmerging Countries

Tiers	Countries		2009 GDP based on PPP valuation (Trillion USD)	Incremental Pharma Market Growth from 2009-13 (Billion USD)
Tier 1	1: China		9	40B+
Tier 2	2: Brazil 3: Russia 4: India		2-4	5-15B
Tier 3	5: Venezuela 6: Poland 7: Argentina 8: Turkey 9: Mexico 10: Vietnam 11: S. Africa	12: Thailand 13: Indonesia 14: Romania 15: Egypt 16: Pakistan 17: Ukraine	<2	1-5B

Source: IMS Health, cited in IMAP (2011, p.5)

Besides an explosive growth expected from the pharmerging countries, there are also other drivers that should not be omitted. It is worth mentioning that the phenomenon of unmet medical needs also represents substantial growth potential for the pharmaceutical companies. For instance, in the majority of established markets, ageing population together with certain lifestyle patterns as poor diet, lack of physical activity, smoking, etc., lead to increase in incidence of chronic diseases, namely cancer, cardiovascular/metabolic and respiratory diseases (AstraZeneca, 2012).

Moreover, it should also be taken into consideration that globally, there are approximately 36 million deaths each year from non-communicable diseases. However, 80% of those take place in lower and middle income countries. There is no doubt that there is an enormous space for improvement, and thus the opportunity for drug makers (AstraZeneca, 2012).

Last but not least, the growth driver related to the advances in science and technology will be discussed. It cannot be denied that the innovation, leading to new drug discovery and subsequent introduction to the market, plays a key role in addressing unmet medical needs. Therefore, advances in disease understanding as well as the application of new technologies will be required in order to ensure the delivery of new medicines. These advances include approaches related to personalized healthcare, predictive science, as well as new types of therapy (AstraZeneca, 2012).

2.1.3 Challenges

Despite the fact that world pharmaceutical market continued to grow in 2010, the research-based pharmaceutical companies face numerous challenges, comprising:

- Regulatory requirements;
- Pricing pressures;
- Patent expiries and genericisation;
- R&D productivity.

In general terms, it can be stated that the pharmaceutical industry is one of the most heavily regulated. This reflects public interest in enabling safe, effective, high quality medicines that are promoted in a responsible manner (AstraZeneca, 2012). The Food and Drug Administration (FDA) in the USA, the European Medicines Agency (EMA) in the EU, the Pharmaceuticals and Medical Device Agency (PMDA) in Japan, and the State Food and Drug Administration (SFDA) in China, are examples of health authorities, who impose regulatory requirements on firms within the industry in order to assure previously mentioned public interests.

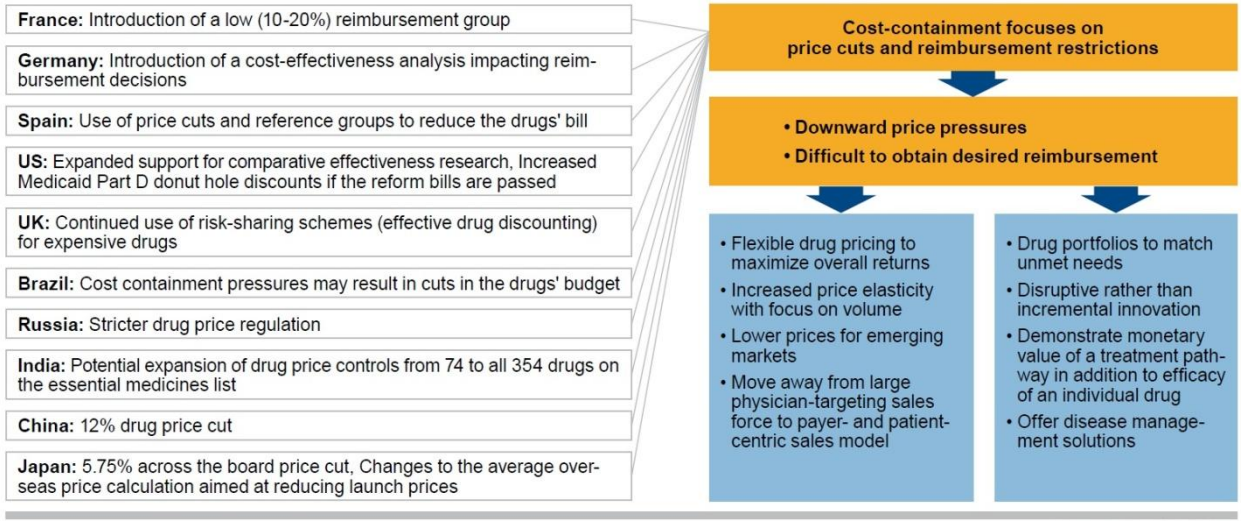
In recent years, it can be concluded that the regulatory pressures on pharmaceutical firms has grown steadily. For instance, in the USA, the FDA Amendments Act of 2007 has forced the Food and Drug Administration to toughen standards for new drugs' approvals, by introducing mandatory risk evaluation and mitigation strategies. This can be seen as an example of a global trend of even higher standards to be met in order to get new drugs' approvals. Obviously, this

leads to higher failure rates, associated with substantial costs for the pharmaceutical companies (IMAP, 2011).

As the majority of pharmaceutical sales are still generated in highly regulated markets, where governments seek solutions that would not lead to further public deficits, it is not surprising that pharmaceutical companies face increasing pressures related to their products' pricing. What is more, these particular pressures have intensified with the current economic meltdown.

Number of mechanisms has been employed in order to increase the pricing pressures on the industry. To do so, stricter regulatory price controls and other healthcare-related reforms have been introduced. More specific description of these tools applied by selected countries is outlined in the exhibit below.

Exhibit 7: Price Cuts and Reimbursement Restrictions in Selected Markets



Source: IMAP (2011, p.5)

Due to the fact that patents only protect pharmaceutical product over a limited period of time, its expiry or early loss may result in the availability of generics. The generic drug can be defined as "a medicinal product which has the same qualitative and quantitative composition in active substances and the same pharmaceutical form as the reference medicinal product, and whose bioequivalence with the reference medicinal product has been demonstrated by appropriate bioavailability studies." (Directive 2001/83/EC, article 10/2b).

Obviously, these generic versions of medicines are offered at a significantly lower price compared to the original, innovator drugs. As mentioned in the IMAP report (2011, p.3), generic drugs are 30 - 80% less costly in comparison with their original equivalents. Such low prices can be set predominantly due to substantially lower R&D expenses from the side of generic manufactures.

In the IMAP report (2011, p.3), the generic sector is summarized as follows "due to many patent expirations, the generic drug industry has experienced great growth in the past few years. The global market for generic drugs was worth $107.8 billion USD in 2009 and is projected to reach

$129.3 billion USD by 2014." This is partially caused by increasing cost pressures on healthcare discussed previously. Because of this phenomenon, the generic pharmaceutical usage has grown sharply. For instance, in the USA, generic medicines account for 80% of the market by volume, and what is more, further growth is expected to take place, which will lead to more intensified competition within the industry (AstraZeneca, 2012).

Last but not least, the R&D productivity should not be omitted when discussing major challenges pharmaceutical companies, specifically the research-based ones, have to face. This is a crucial domain to be addressed, as figures suggest that overall, the R&D pipelines dry out in recent years. The global investment in R&D by the top 500 pharmaceutical and biotech companies reached an estimated USD 133 billion in 2011, which is a 93% increase from $69 billion in 2002. Nevertheless, over the same time frame, the number of new drug launches per year in the USA, which is one of the most important markets, stayed broadly the same, with an annual average of 25 (AstraZeneca, 2012).

In order to bring pharmaceutical R&D back to higher productivity levels, companies have among others started reviewing their R&D structures and models. For instance, GlaxoSmithKline has restructured its R&D operations, which is hoped to lead to more entrepreneurial culture, and thus support innovation (IMAP, 2011). Another ways of addressing the R&D productivity challenges might include (AstraZeneca, 2012, p.17):

- focusing on specific therapeutic areas, and exiting those where success has been poor;
- improving decision-making processes and governance, so that unsuccessful projects are identified as soon as possible, before significant costs are spent;
- reducing costs and enhancing process efficiency, by employing tools as Six Sigma etc.;
- creating a collaboration-centric business model, including academic collaborations and co-development agreements, leading to development risks as well as costs sharing;
- searching for high quality science, technologies, targets, drug candidates, and/or entire drug pipelines externally.

2.1.4 Research and Development

It is crucial to possess a basic understanding of the R&D process in the context of research-based pharmaceutical sector in order to be able to examine the R&D investment - profitability or market value relationship.

There is no surprise that in general, the pharmaceutical firms' R&D investments realized this year will not have an immediate impact on their profitability or market value. If a drug producer succeeds in a new drug discovery resulting from current R&D investment, it takes some time till the drug is introduced to the market, and starts generating profits. Theoretically, the same can be concluded for R&D's impact on the market value. In the context of the above portrayed example of new drug discovery, the effect of R&D investment should lead to an increase in firm's market value once it is highly probable the new drug will actually be introduced to the market and will be commercially successful.

Therefore, for the purpose of this thesis, it is important to have an overview of these processes of research and development, as this would allow us, among others, to approximate the time lag between R&D investment realization and its impact on profitability and market value.

However, before focusing on R&D processes specifically within the pharmaceutical industry, first, the general definition of R&D, valid not only for the pharmaceutical industry will be presented.

According to Bragg (2002, p.228), the definition of R&D consists of two parts.

- *Research* can be understood as a planned search for the discovery of new knowledge. It is evident that the intent of research is that it will lead to either improved existing product or process, or creation of a new one. Nevertheless, there is no guarantee that this will happen, thus the primary definition of research is "the search for new knowledge" (Bragg, 2002, p.228).
- *Development* is "the enhancement of existing products or processes, or creation of entirely new ones" (Bragg, 2002, p.228). Alternatively, this term means "the application of knowledge for specific business purposes" (Bragg, 2002, p.228).

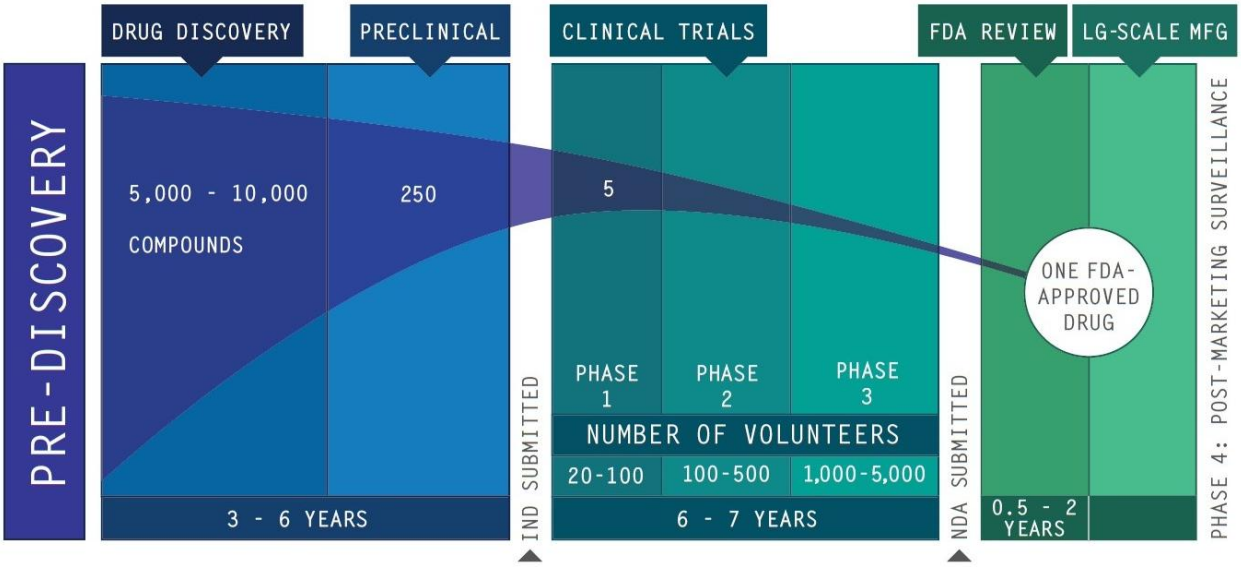
It is worth noting that both research and development do not necessarily have to be the direct outcome of in-house efforts. These can be acquired from any source, including a purchase from another company, for instance as a part of an ongoing research agreement or through the outright buyout of another business (Bragg, 2002).

The exact meaning of term R&D has already been specified, so in the following part, the specifics of research and development process within the pharmaceutical industry will be discussed.

According to report published by Deutsche Bank (2003), the R&D process is significantly time-consuming, complex, and what is more, highly risky. Also, such process is extremely costly, as it is estimated that the average costs of R&D of every single successful drug range from USD 800 million to USD 1 billion. The costs associated with thousands of failures are reflected in this estimate (PhRMA, 2007). Concerning the failure rates, it is argued that for every 5.000-10.000 compounds that enter the R&D pipeline, solely one receives approval (PhRMA, 2007).

As illustrated in Exhibit 8, the new drug R&D process comprises several phases that can be divided into two major subgroups – discovery and development processes.

Exhibit 8: The Pharmaceutical R&D Process – Stages and Timing



Source: PhRMA (2007, p.11)

The discovery process, represented by blue-colour filling in the above chart, can be subdivided into pre-discovery, drug discovery and pre-clinical phase. Similarly, the development process can be split into IND submission, clinical trials, NDA submission & review, manufacturing, and post-marketing phase.

1. Discovery Process

The discovery process contains all early research activities to identify a new drug candidate. It also includes such candidate's laboratory testing. By the end of this discovery process, which takes approximately 3 to 6 years, researchers hope to have a promising candidate drug, ready to be tested on people (PhRMA, 2007).

- *Pre-discovery*

  The process of drug discovery is initiated by gathering the knowledge of specific disease. Therefore, before any new drug can be discovered, researchers and scientists attempt to understand the disease to be treated, which means to identify the underlying cause of the condition. These researchers and scientists "try to understand how the genes are altered, how that affects the proteins they encode and how those proteins interact with each other in living cells, how those affected cells change the specific tissue they are in and finally how the disease affects the entire patient. This knowledge is the basis for treating the problem" (PhRMA, 2007, p.2).

  It is worth noting that not only researchers from the pharmaceutical industry contribute to this knowledge base. Academia, government scientists and others also play a key role in enhancing such knowledge. Nevertheless, despite this enlarging knowledge base together with new tools, the research takes many years of intensive work, and often does not bring desired output. And even if the research does not lead to dead ends, it will take many more years before the new treatment gets to the first patient (PhRMA, 2007).

Once researchers have accumulated enough understanding of the underlying cause of a disease, so-called 'target' for potential new drug is selected. A target is in general a specific molecule, gene or protein for example, which is involved in a particular disease. Obviously, it is important to identify such target that can be affected by a drug (PhRMA, 2007).

After the target is picked up, there are numerous testing processes that attempt to confirm the target and its role in the disease in examination (PhRMA, 2007).

- *Drug discovery*

  Equipped with the necessary understanding of the disease, researchers search for a molecule, 'lead compound' in other words, that would act on previously selected target to modify the disease course. If proven successful over numerous years of testing, such lead compound can finally become a new drug. These tests include for instance Early Safety Tests that assess whether the lead compound is not toxic, is metabolized efficiently and effectively, is absorbed into the bloodstream etc. (PhRMA, 2007).

  Lead compounds that successfully pass these tests are then optimized, which means that they are altered to become more effective and safer. By modifying compound's structure, researchers can give it different properties, which would lead to potential side effects reduction for example (PhRMA, 2007).

- *Preclinical testing*

  Preclinical testing consists of laboratory as well as animal testing. The objective is to validate that the medicine is safe enough for human testing. In short, scientists try to understand how exactly the given potential drug works and how its safety profile looks like. This is very important as for example the US Food and Drug Administration (FDA) requires thorough testing prior to approving any human testing (PhRMA, 2007).

  With the completion of preclinical testing, the discovery phase ends. After screening approximately 5 to 10 thousand compounds in the very beginning, at this stage, scientists are usually left with the group of 1 to 5 candidate drugs, which will undertake the clinical trials (PhRMA, 2007).

2. Development Process

Before the regulator - FDA for instance - finally approves a candidate drug, thorough extensive tests in humans must be conducted. This includes a series of clinical trials, each focusing on specific objectives as well as requirements. It is concluded that these trials are both costly and time-consuming. Moreover, the risks of failure are significant, as clinical trials result more often in failure than in a success. On average, the development process takes between 6 to 7 years (PhRMA, 2007).

- *Investigational New Drug (IND) application and safety*

  Prior to any clinical trial, researchers have an obligation to file so-called Investigational New Drug (IND) application with the regulator, as FDA. Such application states the results of preclinical testing, the candidate drug's chemical structure, its expected impact in human body, listing of possible side effects etc. Every IND also includes a clinical trial plan that provides information on how, where and by whom the studies will be conducted. The regulator's role is to review this IND application and approve clinical trials in case it is concluded that participants in these trials will not be exposed to unreasonable level of risk (PhRMA, 2007).

- *Clinical trials*

  Clinical trials' main purpose is to reveal whether the drug is safe as well as effective. The candidate drug is tested in the following three trial phases.

  - Phase I Clinical Trial

    This phase represents initial safety trials of the candidate drug. In majority of cases, these are conducted on a relatively small number of healthy volunteers. The exception is life-threatening diseases, as cancer for instance, where phase I trials are conducted in ill patients. According to Deutsche Bank's report (2003, p.34), "around 80-90% of phase I drug candidates typically fall by the wayside."

  - Phase II Clinical Trial

    In the course of this phase, the effectiveness of the drug candidate is usually evaluated on a sample of 100 to 500 patients with the disease under consideration. The questions to be answered in this phase are, whether the drug is working by the envisaged mechanisms, or whether it leads to improvements of patients' conditions. Optimal dose strength and schedules for using the drug are also analyzed (PhRMA, 2007). It is empirically demonstrated that fewer than 40% of drug candidates will successfully proceed from phase II to phase III of clinical trials (Deutsche Bank, 2003).

  - Phase III Clinical Trial

    In order to be able to collect statistically significant data regarding candidate drug's safety, efficacy, and the overall benefit-risk relationship, the phase III trials are studied in a larger number of patients, which means about 1 to 5 thousand individuals. It is worth mentioning that this phase is both the most time-consuming as well as the most expensive, predominantly due to the highest sample of patients (PhRMA, 2007).

    During the phase III, and even before, large number of other crucial studies is conducted by researchers, including plans for full-scale production, or preparation for the complex application required by regulators (PhRMA, 2007).

- *New Drug Application (NDA) and Approval*

  If the data analyzed after the completion of all three clinical trial phases show that the candidate medicine is safe as well as effective, so-called NDA is filed. This is detailed document, which can have 100 thousand pages or more, requesting the authority, FDA in the case of US environment, for an approval to market the drug (PhRMA, 2007).

  FDA experts examine all the information stated in the NDA, in order to determine whether the drug is safe and effective enough to be approved. Three possible scenarios may occur: first, the regulator approves the medicine; second, further information is requested before an approval can be granted, or third, the application is rejected (PhRMA, 2007).

- *Manufacturing*

  A move from small-scale to mass-scale production represents another challenge research-based pharmaceutical companies have to address once the new drug was approved to be marketed. Often new manufacturing plants have to be built or substantial reconstructions of old facilities must be done, due to the fact that manufacturing processes vary significantly from medicine to medicine. What is more, each production plant must also meet strict regulatory requirements (PhRMA, 2007).

- *Post-marketing surveillance – Phase IV*

  Even though the drug is approved to be manufactured, distributed and marketed, the clinical research on a new drug continues. With increase in number of patients using the new medicine, companies are obliged to continue to monitor the situation carefully. Periodic reports, including cases of adverse effects are submitted to regulators (PhRMA, 2007).

  In some cases, the relevant authority may request the company to conduct additional studies, Phase IV studies, on already approved medicine. This is to evaluate long term safety or assess how the drug affects specific subgroups of its users (PhRMA, 2007).

Overall, the process of bringing new drug to the market lasts, on average, between 10 to 15 years. This is key information, due to the fact that in order to evaluate the effects of R&D investments on firms' profitability or market value, this time aspect has to be taken into consideration.

For the purpose of this thesis, it will be assumed that the R&D expenses will have an impact on firms' profitability / market value in the horizon of 10 years. This lowest figure from the range of 10 to 15 years was chosen because the higher the lag, the more challenging it is to access all the data needed - mainly firms' financial reports - required for the analysis.

2.2 Literature Review - R&D Link to Profitability / Market Value

Numerous studies have been conducted in order evaluate, whether there is a link between R&D spending and firms' profitability, or alternatively market value. There are authors who argue that investment in R&D contributes positively to firms' performance. Such conclusion was drawn for instance from extensive research conducted by Ike and Olibe (2010), who examined R&D investment - firm performance linkage among US manufacturing and services industries over an 18-year period on a sample covering 26 500 firm-years.

In the context of pharmaceutical industry, similar conclusion, arguing that there is a link between the R&D spending and firm's performance, is presented by Hajiheydari, Dastgir and Soltani (2011). Based on their study of twenty multinational pharmaceutical companies, they conclude that there is a strong and positive relationship between R&D expenditures and the profitability of pharmaceutical companies.

Another similar research outcome was derived from the study done by Hanel and St-Pierre (2002). These authors developed and tested a model in which profitability of R&D performing companies is a function of determinants such as capital stock, market share, growth of sales, and last but not least, firm's own technological effort. The outcome of the study confirms the thesis that R&D investment has a direct, positive effect on profitability.

The study published by Nord (2011), investigating whether or not research and development expenditures have a positive and significant effect on market value from the perspective of the pharmaceutical industry, also finds a significant as well as positive relationship between these two variables.

Nevertheless, despite all these studies arguing that there is a link between R&D expenses and firm's profitability as well as market value, it is worth emphasizing that there are numerous researches contradicting these conclusions.

For instance, a study published by consulting firm Booz Allen Hamilton (cited in Business Wire, 2005) argues that "there is no direct relationship between R&D spending and significant measures of corporate success such as growth, profitability, and shareholder return". On the basis of the analysis of the world's top 1.000 corporate research and development spenders, the key findings include the quotation that money does not buy results. This is explained in the following manner: "While the study identified individual success stories, there is no discernible statistical relationship between R&D spending levels and nearly all measures of business success, including sales growth, gross profit, operating profit, enterprise profit, market capitalization, or total shareholder return." (Booz Allen Hamilton cited in Business Wire, 2005).

What is more, Koku (2010), who examined the relationship between R&D expenditure and the profitability specifically in the pharmaceutical industry by using annual size-adjusted R&D and advertising budgets as independent variables on standardized excess abnormal returns, also summarizes that there is no relationship between profitability and annual R&D budgets.

From the above literature review, it is evident that there is a high degree of controversy regarding the R&D spending – profitability; or R&D spending - market value linkage. This thesis will attempt to bring certain degree of simplicity and clarity on this matter.

2.3 Analytical Tools

In this section, first, the rationale of R&D spending harmonization will be presented, which will be followed by profitability and market value ratios description that will be used in the practical part of the thesis. Finally, as the objective is to evaluate whether there is a positive relationship between the level of R&D spending on one side, and profitability as well as market value on the other side, the relevant statistical method of regression will be covered.

2.3.1 R&D Spending

As selected pharmaceutical companies vary in terms of their sizes, reporting currencies, etc., there is a need first to introduce such measure that would provide relative, unit-free indicator of R&D expenses level of each and every company of the focus. This can be achieved by dividing each firm's total annual R&D expenses by its total sales.

R&D/Sales ratio is widely used due to the fact that it ensures for instance comparability of firms' levels of R&D spending with their peers. Moreover, its interpretation is straight-forwards, as it shows, how much is spent on R&D from one unit of revenue.

2.3.2 Profitability & Market Value Ratios

Profitability ratios express how well firm's resources are being used to generate profit, and how efficiently the firm is being managed (Gitman and McDaniel, 2009).

Return on equity, assets and sales are widespread profitability ratios that were found to be suitable for the purpose of this thesis, and therefore will be applied in the practical part.

2.3.2.1 **Return on Equity**

The Return on Equity (ROE) examines profitability from the side of the equity investor. This is achieved by relating profit attributable to such equity investor, i.e. net profit after tax and interest expense, to the book value of the equity (Damodaran, 2011).

$$ROE = \frac{Net\ income}{Book\ value\ of\ equity}$$

Source: Damodaran (2011, p.620)

2.3.2.2 **Return on Assets**

The Return on Assets (ROA) is one of the key measures of profitability. This ratio is obtained by dividing company's earnings by its total assets, regardless of whether these were financed from own equity or borrowings from creditors (Kislingerová et al., 2007).

There are numerous forms of Return on Assets ratio, varying based on what specific sort of earnings is used for the calculation. Nevertheless, for the purpose of comparing companies with

diverse capital structures as well as income tax burdens, it is appropriate to employ EBIT (earnings before interest and taxes) in order to calculate ROA (Kislingerová et al., 2007). That is why in the following parts of this thesis the below stated form of Return on Assets based on EBIT will be applied.

$$ROA = \frac{EBIT}{Total\ assets}$$

Source: Kislingerová et al. (2007, p. 84)

2.3.2.3 **Return on Sales**

The Return on Sales ratio (ROS) provides clear evidence about company's effectiveness. In case there are problems spotted in the context of ROS analysis, it can be assumed that other issues will be identified in all sorts of other domains within the company (Kislingerová et al., 2007).

Similarly to the ROA ratio, the Return on Sales can be formed based on either EBIT or other form of earnings, such as EAT (earnings after tax). However, for the purpose of this thesis, the construction of ROS based on EBIT in the numerator will be used.

$$ROS = \frac{EBIT}{Net\ sales}$$

Source: Kislingerová et al. (2007, p. 85)

As it is desirable to observe whether firms who invest more in R&D also reach higher market value, which is determined by investors' perception of the future earning power of a firm (Gallagher and Andrew, 2007), the market value ratios will also be examined in this thesis.

Namely, Price-to-Sales and Price-to-Book ratios will be used for the purpose of assessing the link between pharmaceutical firms' R&D expenditures and their market values.

2.3.2.4 **Price-to-Sales**

This ratio captures the relationship between the market capitalization and sales, or alternatively the share price and sales per share. Therefore, it reflects how many times sales the investors value the company on the marketplace.

$$P/S = \frac{Market\ capitalization}{Sales} = \frac{Share\ price}{Sales\ per\ share}$$

Source: Fernández (2002, p.147)

2.3.2.5 **Price-to-Book**

The price to book ratio (P/BV) measures the ratio between market value and book value (Vernimmen et al., 2011). This can be interpreted as how much the market is willing to pay for one monetary unit of equity. Therefore, for companies having P/BV higher than 1, it can be concluded that the market believes the company's future earnings are worth more than the firm's liquidation value. On the other side, for those companies having P/BV less than 1, it means that if such company liquidated and paid off all creditors, more would be left for the shareholders than what the shares could be sold for in the stock market (Gallagher and Andrew, 2007).

Unlike Price/Earnings and other similar measures, P/BV is applicable even in case of negative earnings of cash flows generated by a company, which is an important asset of this ratio. Moreover, this ratio provides relatively stable and intuitive measure of value when applied to similar firms in the same industry (Baker and Powell, 2005). That is why P/BV ratio was identified to be suitable for the purpose of this diploma thesis.

$$P/BV = \frac{Price\ per\ share}{Book\ value\ per\ share} = \frac{Market\ capitalisation*}{Book\ value\ of\ equity}$$

** Market capitalisation = Price per share x Number of shares outstanding*

Source: Vernimmen et al. (2011, p.423)

2.3.3 Regression Analysis

To assess whether the profitability as well as market value of selected pharmaceutical companies is dependent on the level of R&D spending, the regression analysis will be performed.

Regression analysis is a statistical method for investigating relationships between variables. Such relationship is expressed in the form of an equation that involves so-called dependent variable and one or more explanatory - independent - variables (Chatterjee and Hadi, 2006).

For the purpose of assessing the relationship between R&D spending (independent variable), and profitability or alternatively market value ratio (as a dependent variable), the simplest type of regression, so-called simple linear regression, connecting one independent and one dependent variable, will be used.

This simple linear regression was selected mainly because it is believed that this model would sufficiently capture the essence of the relationship between the variables in question. What is more, this method, compared to for instance multiple regression analysis, or models based on exponential or logarithmic functions, provides relatively straight-forward, easily interpretable outputs, which is beneficial for the purpose of this thesis.

It is worth emphasizing that this regression analysis model was also employed by other authors focusing on similar problem resolution, as for example study of Hajiheydari et al. (2011), named 'The Effect of Research and Development Costs on the Profitability of Pharmaceutical Companies'.

2.3.3.1 **Simple Linear Regression – Model & Estimated Equation**

The below noted equation, describing how dependent variable *y* is related to independent variable *x* and an error term, represents the regression model, in this context simple linear regression model.

$$y = \beta_0 + \beta_1 x + \varepsilon$$

Source: Anderson, Sweeney, and Williams (2011, p.485)

β_0 and β_1 represent parameters of the model, and epsilon a random variable, so-called error term. As no model will be able to fully capture the behaviour of the dependent variable, the error term can be seen as the unexpected element, accounting for the variability in *y* that cannot be comprised by the linear relationship between *x* and *y* (Anderson, Sweeney, and Williams, 2011).

In order to estimate a relationship portrayed by the regression model, the method called ordinary least squares (OLS) is used. In fact, OLS generates estimates of parameters β_0 and β_1, noted as b_0 and b_1, that are used to predict the expected value of *y* ($E_{(y)}$). More precisely, the equation of $E_{(y)}$ is expressed as follows:

$$E_{(Y)} = b_0 + b_1 x$$

Source: Anderson, Sweeney, and Williams (2011, p.487)

The above equation is referred to as the estimated simple linear regression equation. More detailed explanation of the process of calculation of this estimated regression equation by the use of OLS method will not be provided, as MS Excel tools will provide the output equation without a need of manual calculation.

Once the model that attempts to explain the behaviour of an independent variable is estimated, it is important to know how accurately the estimated regression equation actually fit the data, how strong is the relationship between variables *x* and *y*, as well as whether the relation can be interpreted as statistically significant. For this purpose, the coefficient of determination, the correlation coefficient, and so-called t-Test will be covered.

However, it is worth emphasizing that the aim of this thesis is not to provide an exhaustive description as well as complex mathematical derivation of these statistical measures, as these will be obtained by analysis run in MS Excel. The goal is to understand the fundamental meaning of these measures and be able to interpret its outputs obtained from an Excel's regression.

2.3.3.2 **Coefficient of Determination**

The coefficient of determination provides information on how well the estimated regression equation fits the actual data. In other words, it measures the proportion of variability in *y*, explained by the model (Estrada, 2005), therefore the goodness of such model.

The value a coefficient of determination is ranging from the minimum of 0 and maximum of 1. Obviously, the higher this value, the better the model (Estrada, 2005).

2.3.3.3 **Correlation Coefficient**

In the context of linear regression, the correlation coefficient is defined as "a descriptive measure of the strength of linear association between two variables, *x* and *y* (Anderson, Sweeney, and Williams, 2011, p. 502). Concerning values of the correlation coefficient, these can range between -1 and +1. A value of +1 shows that there is a perfectly positive linear relationship between the two variables. A value of -1 indicates that *x* and *y* are also perfectly related, but in a negative linear sense. In case a value of the correlation coefficient is close to 0, it can be concluded that *x* and *y* are not linearly related (Anderson, Sweeney, and Williams, 2011).

Exhibit 9: Correlation Coefficient: Strength & Direction of Correlation

Source: Russell Investments (2012)

2.3.3.4 **Testing for Significance**

In order to evaluate the degree of association, i.e. statistical significance, between a dependent and independent variable of the linear regression analysis, so called t-Test will be performed.

The underlying thought is that if *x* and *y* are linearly related, the parameter β_1 in the regression model $y = \beta_0 + \beta_1 x + \varepsilon$ must be different from zero. The purpose of this test is to assess whether it can be concluded that $\beta_1 \neq 0$. To do so, the sample data will be used and the following hypothesises will be tested (Anderson, Sweeney, and Williams, 2011).

$H_0: \beta_1 = 0$
$H_a: \beta_1 \neq 0$

In case H_0 is rejected, it means that $\beta_1 \neq 0$, thus the statistically significant relationship between the two variables exist. In other words, the independent variable plays an important role in

explaining the behaviour of the dependent variable. On the other hand, if H_0 is not rejected, in fact, there will be lack of evidence to conclude that a significant relationship exists between these variables (Anderson, Sweeney, and Williams, 2011).

As all the data needed to run the t-Test will be gathered by performing the regression analysis in MS Excel, no further theoretical insights regarding such test will be provided, as this exceeds the scope of this diploma thesis. Instead, a process of hypothesis testing based on the Excel's regression analysis output will be outlined.

As explained by Estrada (2005, p.373), the easiest way to test the above hypothesises is to compare p-value of the t-statistic, which is part of the Excel's regression output, with a chosen significance level (α). Due to the fact that the most widely used significance level in finance and economics is 5% (Estrada, 2005, p.373), this value of 5% will also be chosen for the testing in the practical part of this thesis. The pattern of hypothesis testing is as follows.

- if $p < \alpha$: Reject the hypothesis H_0
- if $p > \alpha$: Do not reject the hypothesis H_0

Therefore, if the calculated p-value is smaller than 5%, the dependence between variables *x* and *y* is said to be statistically significant (at the 5% level of significance). However, if p is greater than 5%, such dependence is statistically insignificant, at the level of 5% (Estrada, 2005).

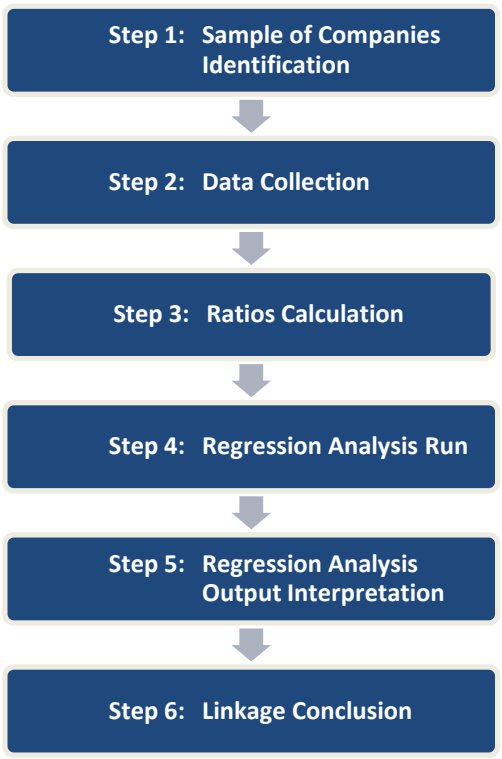
3 Practical Part

This practical part will attempt to provide a comprehensive answer to the research question of the thesis, which is whether there is a link between level of R&D expenses and profitability, or market value, i.e. whether those firms who spend more funds on R&D become more profitable, as well as more valuable from investors' perspective.

3.1 The Process of Relationship Assessment

In order to examine the linkage between R&D expenditures and profitability as well as market value, the following six-step process will be carried out.

Exhibit 10: The Process of Link Examination



Source: Author

- *Step 1: Sample of Companies Identification*

  Firstly, it is crucial to define the sample of companies, for which the relationship between R&D investments and profitability as well as market value will be assessed. In this thesis, this sample was chosen based on the article published by Reuters (2010), where top 20 pharmaceutical companies, ranked by global prescription drug sales for the 12 months through September 2009 were identified.

These companies are: Pfizer, Novartis, Sanofi-Aventis, GlaxoSmithKline, AstraZeneca, Roche, Johnson & Johnson, Merck & Co., Eli Lilly, Abbott, Teva, Bayer, Wyeth, Amgen, Boehringer, Takeda, Bristol-Myers, Schering-Plough, Daiichi Sankyo and Novo Nordisk.

Nevertheless, from this list of top 20 pharmaceutical companies by global prescription drug sales, five firms were excluded for the purpose of this thesis. Due to the fact that Teva's core business is to develop, produce and market generic drugs (FT, 2012o), this company will not be included to the analysis. Both Sanofi-Aventis and Daiichi Sankyo were also excluded due to lack of input data for the regression analysis. Specifically, there were no relevant figures found regarding their yearly R&D budgets for the period from 1997 till 2001. Finally, on October 2009, Wyeth was acquired by Pfizer (FT, 2012p), and since November 2009, Schering-Plough is part of Merck & Co. (Reuters, 2009). Therefore, these two companies were also excluded from the regression analysis of this thesis.

The below table summarizes the total number of 15 companies that represent the sample, for which the data will be collected and regression analysis will be run.

Exhibit 11: Selected Companies & Global Prescription Drug Sales in 2009

Company	Sales [USD billion]*	Notes
Pfizer	41,7	
Novartis	36,7	
Sanofi-Aventis	35,1	Excluded: Data for R&D (97-01) not available
GlaxoSmithKline	34,3	
AstraZeneca	33,2	
Roche	31,3	
Johnson & Johnson	26,9	
Merck & Co	25,5	
Eli Lilly	19,6	
Abbott	19,4	
Teva	15,7	Excluded: Core business: Generics
Bayer	15,4	
Wyeth	14,8	Excluded: Acquired by Pfizer
Amgen	14,8	
Boehringer	14,6	
Takeda	14,4	
Bristol-Myers	14,2	
Schering-Plough	13,1	Excluded: Part of Merck & Co.
Daiichi Sankyo	8,5	Excluded: Data for R&D (97-01) not available
Novo Nordisk	8,2	

* figures for 12 months through September 2009

Source: Author, based on Reuters (2010)

- *Step 2: Data Collection*

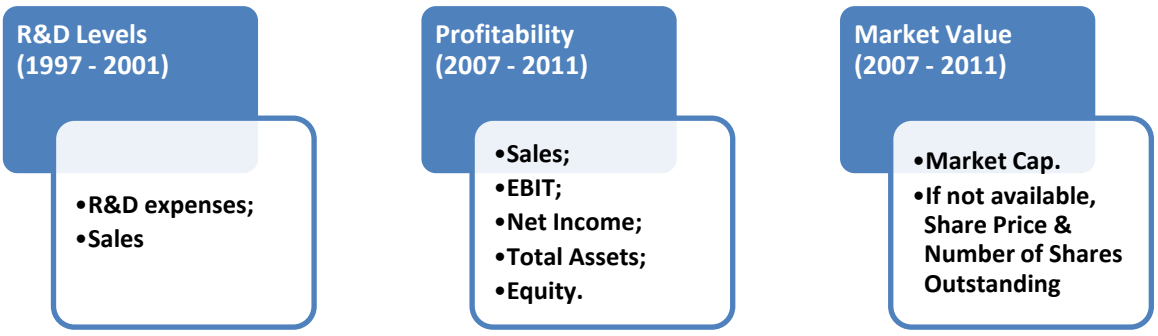
  One of the major challenges in order to be able to assess the relationship between R&D expenditures and firms' profitability or market value, is to gather all the input data needed for the regression analysis.

  As explained in the section *2.1.4 Research and Development*, the R&D process is, among others, highly time consuming, as - on average - it takes a pharmaceutical company between 10 to 15 years to bring new medicine to the market. That is why the time lag has to be taken into consideration when examining the effects of R&D investments on firm's profitability or market value. As mentioned previously, for the purpose of this thesis, it will be assumed that the R&D investment will have an impact on profitability / market value in the time horizon of 10 years. Despite the selection of the lowest number from the range, it will be highly demanding to collect all the data needed for each and every of the 15 companies selected.

  Firstly, data about each company's annual R&D expenditures as well as Sales for years 1997 - 2001 will be collected. These data will be gathered from corporate annual reports accessed through *morningstar.com* database. Secondly, source data needed for the calculation of profitability ratios will be acquired from *FT.com* and other reliable sources. More specifically, the annual sales, EBIT, net income, total assets and equity figures will be retrieved for each of the 15 selected companies, over five-year period from 2007 till 2011. Finally, historical annual market capitalisation figures for years 2007 - 2011 will be gained from annual reports, or alternatively calculated based on information provided in the SEC reports and other publically accessible sources.

  The chart below summarizes the overall data collection process that needs to be carried out.

Exhibit 12: Data Required for Each of 15 Selected Companies



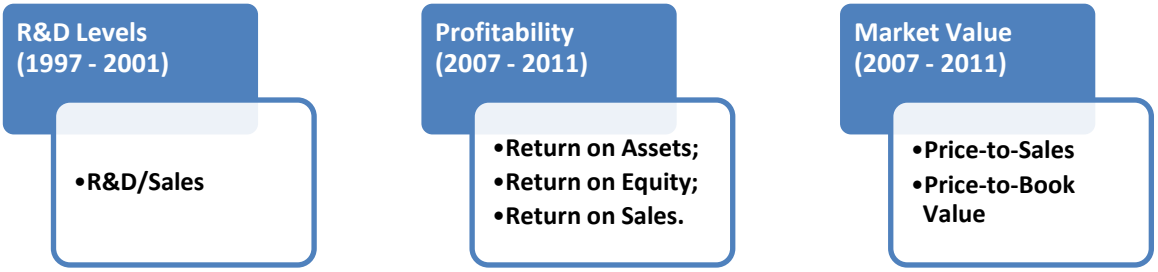
Source: Author

- *Step 3: Ratios Calculation*

  After retrieving the source data, the relative R&D levels, obtained by dividing each firm's annual R&D expenditures by annual sales, will be calculated. Also, calculations of profitability ratios, namely Return on Assets, Return on Equity and Return on Sales, as well as market value ratios – Price-to-Sales and Price-to-Book Value, will be done.

  The exact formulas of these ratios can be found in the section *2.3 Analytical Tools*. The following exhibit provides an overview of Step 3: Ratios Calculation.

Exhibit 13: Ratios Calculated for Each of 15 Selected Companies



Source: Author

- *Step 4: Regression Analysis Run*

  After calculating all the ratios outlined in the previous step, for every single company, there will be the R&D/Sales ratios available for years 1997, 1998, 1999, 2000 and 2001, as well as profitability and market value ratios for years 2007, 2008, 2009, 2010 and 2011.

  This data set, containing five values per company of both R&D/Sales (as an independent variable *x*) and one of profitability or market value ratios lagged by ten years (as a dependent variable *y*) will be subject to the regression analysis. It is worth noting that due to the fact that there are three profitability and two market value ratios, in total, the regression analysis will be run five times, for each of these five ratios separately.

  The regression analysis itself will be done by using MS Excel's regression add-on. The complete reports of the analysis will be provided in the Appendix.

- *Step 5: Regression Analysis Output Interpretation &*
  Step 6: Linkage Conclusion

  By applying theoretical concepts of regression analysis described in the theoretical part under section *2.3 Analytical Tools*, the results of the analysis will be interpreted and conclusions regarding the R&D expenses - profitability or market value link presented.

Nevertheless, prior to focusing on the core part of this thesis, which is the regression and its output interpretation, more detailed description of the fifteen selected companies, together with the source data for the analysis will be provided. In fact, this following part will cover steps 1 - 3, as the sample of companies will be presented (Step 1), and all the required data (Step 2) as well as ratios (Step 3) will be outlined.

3.2 Selected Companies: Facts & Figures (Step 1 - 3)

3.2.1 Pfizer Inc.

Pfizer Inc. is a US-based research-oriented, global biopharmaceutical company. Pfizer's operations are managed through five segments: Primary Care; Specialty Care & Oncology; Established Products & Emerging Markets; Animal Health & Consumer Healthcare, and Nutrition. The Company's diversified global healthcare portfolio comprises human and animal biologic and small molecule medicines and vaccines, together with nutritional products and consumer healthcare products. With approximately 104 thousand employees, Pfizer is one of the largest pharmaceutical companies worldwide (FT, 2012a).

Exhibit 14: Pfizer – Level of R&D Investments (in millions of USD)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	2 536	18 975	13,36
1998	3 305	23 231	14,23
1999	4 036	27 166	14,86
2000	4 435	29 355	15,11
2001	4 847	32 259	15,03

Source: Author, based on Pfizer (2002, p.61)

Exhibit 15: Pfizer – Financials & Profitability (in millions of USD)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	48 418	9 278	8 144	115 268	65 010	8,05	12,53	19,16
2008	48 296	9 694	8 104	111 148	57 556	8,72	14,08	20,07
2009	49 269	10 674	8 635	212 949	90 014	5,01	9,59	21,66
2010	67 057	9 282	8 257	195 014	87 813	4,76	9,40	13,84
2011	67 425	12 762	10 009	188 002	82 190	6,79	12,18	18,93

Source: Author, based on FT (2012a)

Exhibit 16: Pfizer – Market Value & Ratios

Year	Market Cap [USD mil.]	Price-to-Sales	Price-to-Book Value
2007	153 132	3,16	2,36
2008	119 047	2,46	2,07
2009	146 448	2,97	1,63
2010	140 290	2,09	1,60
2011	163 923	2,43	1,99

Source: Author, based on Annual Reports/Market Data (see Appendix)

3.2.2 Novartis AG

Novartis AG is a global provider of healthcare solutions. Novartis consists of a multinational group of companies specializing in the research, development, manufacturing and marketing of a range of healthcare products led by pharmaceuticals. Its portfolio comprises medicines, eye care, cost-saving generic pharmaceuticals, preventive vaccines and diagnostic tools, over-the-counter and animal health products. Novartis operates though five segments: Pharmaceuticals, comprising patent-protected prescription medicines; Alcon, which include surgical, ophthalmic pharmaceutical and vision care products; Sandoz, containing generic pharmaceuticals; Vaccines & Diagnostics that include human vaccines and blood-testing diagnostics; and Consumer Health, with over-the-counter medicines (OTC) and Animal Health. Currently, approximately 127 thousand people are employed by Novartis (FT, 2012b).

Exhibit 17: Novartis – Level of R&D Investments (in millions of CHF)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	3 739	31 180	11,99
1998	3 906	31 702	12,32
1999	4 246	32 465	13,08
2000	4 657	35 805	13,01
2001	4 189	32 038	13,08

Source: Author, based on Novartis (2002, p.75)

Exhibit 18: Novartis – Financials & Profitability (in millions of USD)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	38 947	6 781	11 946	75 452	49 223	8,99	24,27	17,41
2008	42 584	8 964	8 195	78 299	50 288	11,45	16,30	21,05
2009	45 103	9 982	8 400	95 505	57 387	10,45	14,64	22,13
2010	51 561	11 526	9 794	123 318	63 196	9,35	15,50	22,35
2011	59 375	10 998	9 113	117 496	65 844	9,36	13,84	18,52

Source: Author, based on FT (2012b)

Exhibit 19: Novartis – Market Value & Ratios

Year	Market Cap [USD mil.]	Price-to-Sales	Price-to-Book Value
2007	123 889	3,18	2,52
2008	113 151	2,66	2,25
2009	124 003	2,75	2,16
2010	133 731	2,59	2,12
2011	137 511	2,32	2,09

Source: Author, based on Novartis (2012, p.177); (2010, p.176); (2009, p.171)

3.2.3 GlaxoSmithKline PLC

GlaxoSmithKline plc (GSK) is global, UK-headquartered healthcare group, with focus on the creation and discovery, development, manufacture and marketing of pharmaceutical products, including vaccines, over-the-counter (OTC) medicines and health-related consumer products. The Company's principal pharmaceutical products comprise medicines in the following therapeutic areas: respiratory, anti-virals, including human immunodeficiency virus (HIV), central nervous system, cardiovascular and urogenital, metabolic, anti-bacterials, oncology and emesis, vaccines and dermatologicals. GSK operates in three primary areas of business: Pharmaceuticals, Vaccines and Consumer Healthcare. It has global manufacturing and R&D presence. In total, the Company has approximately 97 thousand employees (FT, 2012c).

Exhibit 20: GSK – Level of R&D Investments (in millions of GBP)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	1 989	14 938	13,32
1998	2 072	14 938	13,87
1999	2 285	16 164	14,14
2000	2 510	18 079	13,88
2001	2 555	20 489	12,47

Source: Author, based on GSK (2002, p.139)

Exhibit 21: GSK – Financials & Profitability (in millions of GBP)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	22 716	7 593	5 214	31 003	9 603	24,49	54,30	33,43
2008	24 352	7 136	4 602	39 393	7 931	18,11	58,03	29,30
2009	28 368	8 422	5 531	42 862	10 005	19,65	55,28	29,69
2010	28 392	3 783	1 634	42 230	8 887	8,96	18,39	13,32
2011	27 387	7 805	5 261	41 080	8 032	19,00	65,50	28,50

Source: Author, based on FT (2012c)

Exhibit 22: GSK – Market Value & Ratios

Year	Market Cap [GBP mil.]	Price-to-Sales	Price-to-Book Value
2007	70 000	3,08	7,29
2008	67 000	2,75	8,45
2009	69 000	2,43	6,90
2010	64 000	2,25	7,20
2011	74 000	2,70	9,21

Source: Author, based on GSK (2012, p.242); (2011, p.207); (2010, p.199); (2009, p.203); (2008, p.175)

3.2.4 AstraZeneca

AstraZeneca is a global biopharmaceutical company. The Company discovers, develops and commercializes prescription medicines for six areas of healthcare: Cardiovascular, Gastrointestinal, Infection, Neuroscience, Oncology, and Respiratory & Inflammation. AstraZeneca has a range of medicines, including treatments for illnesses, such as its antibiotic Merrem/Meronem and Losec/Prilosec for acid related diseases. The Company's products are for example Crestor, Atacand, Seloken/Toprol-XL, Plendil, Onglyza, Zestril, Symbicort or Zoladex. AstraZeneca owns and operates a range of research and development, production and marketing facilities worldwide. It has operations in more than 100 countries, including China, Mexico, Brazil and Russia, employing more than 57 thousand people (FT, 2012d).

Exhibit 23: AstraZeneca – Level of R&D Investments (in millions of USD)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	2 170	13 166	16,48
1998	2 473	15 402	16,06
1999	2 923	18 445	15,85
2000	2 893	18 103	15,98
2001	2 773	16 480	16,83

Source: Author, based on AstraZeneca (2002, p.111)

Exhibit 24: AstraZeneca – Financials & Profitability (in millions of USD)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	29 559	8 094	5 595	47 988	14 778	16,87	37,86	27,38
2008	31 601	9 144	6 101	46 950	15 912	19,48	38,34	28,94
2009	32 804	11 543	7 521	54 920	20 660	21,02	36,40	35,19
2010	33 269	11 494	8 053	56 127	23 213	20,48	34,69	34,55
2011	33 591	12 795	9 983	52 830	23 246	24,22	42,95	38,09

Source: Author, based on FT (2012d)

Exhibit 25: AstraZeneca – Market Value & Ratios

Year	Market Cap [USD mil.]	Price-to-Sales	Price-to-Book Value
2007	62 360	2,11	4,22
2008	59 370	1,88	3,73
2009	68 110	2,08	3,30
2010	65 082	1,96	2,80
2011	59 807	1,78	2,57

Source: Author, based on Annual Reports/Market Data (see Appendix)

3.2.5 Roche Holding AG

Roche Holding AG is a Swiss-based pharmaceuticals and diagnostics holding company. It belongs to the Roche Group which operates globally through subsidiaries and associated companies. Roche discovers, develops and provides diagnostic and therapeutic products and services from early detection and prevention of diseases to diagnosis, treatment and treatment monitoring. The Company has two divisions: Pharmaceuticals and Diagnostics. Pharmaceuticals division is divided into three sub-divisions, consisting of Roche Pharmaceuticals, Genentech and Chugai. Diagnostics division comprises five sub-divisions, namely Applied Science, Diabetes Care, Molecular Diagnostics, Tissue Diagnosis and Professional Diagnostics. There are approximately 80 thousand people employed by Roche worldwide (FT, 2012e).

Exhibit 26: Roche – Level of R&D Investments (in millions of CHF)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	2 903	18 767	15,47
1998	3 408	24 662	13,82
1999	3 782	27 567	13,72
2000	3 950	28 672	13,78
2001	3 893	29 163	13,35

Source: Author, based on Roche (2002, p.119)

Exhibit 27: Roche – Financials & Profitability (in millions of CHF)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	46 133	14 468	9 761	78 365	45 483	18,46	21,46	31,36
2008	45 617	13 924	8 969	76 089	44 479	18,30	20,16	30,52
2009	49 051	12 277	7 784	74 565	7 366	16,46	105,67	25,03
2010	47 473	13 486	8 666	61 020	9 469	22,10	91,52	28,41
2011	42 531	13 454	9 343	61 576	12 095	21,85	77,25	31,63

Source: Author, based on FT (2012e)

Exhibit 28: Roche – Market Value & Ratios

Year	Market Cap [CHF mil.]	Price-to-Sales	Price-to-Book Value
2007	171 060	3,71	3,76
2008	140 678	3,08	3,16
2009	151 296	3,08	20,54
2010	117 563	2,48	12,42
2011	136 102	3,20	11,25

Source: Author, based on Roche (2012, p.153)

3.2.6 Johnson & Johnson

Johnson & Johnson is a US-headquartered holding company. The Company, together with its subsidiaries, is engaged in the R&D, manufacture and sale of diverse products within the healthcare industry. The Company operates in three segments: Consumer, Pharmaceutical, and Medical Devices & Diagnostics. During the fiscal year ended January 1, 2012, the Company's subsidiaries operated 139 production facilities. Globally, roughly 118 thousand employees work for Johnson & Johnson (FT, 2012f).

Exhibit 29: Johnson & Johnson – Level of R&D Investments (in millions of USD)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	2 373	22 522	10,54
1998	2 506	23 811	10,52
1999	2 768	27 357	10,12
2000	3 105	29 172	10,64
2001	3 591	32 317	11,11

Source: Author, based on Johnson & Johnson (2003, p.58)

Exhibit 30: Johnson & Johnson – Financials & Profitability (in millions of USD)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	61 095	13 283	10 576	80 954	43 319	16,41	24,41	21,74
2008	63 747	16 929	12 949	84 912	42 511	19,94	30,46	26,56
2009	61 897	15 755	12 266	94 682	50 588	16,64	24,25	25,45
2010	61 587	16 947	13 334	102 908	56 579	16,47	23,57	27,52
2011	65 030	12 361	9 672	113 644	57 080	10,88	16,94	19,01

Source: Author, based on FT (2012f)

Exhibit 31: Johnson & Johnson – Market Value & Ratios

Year	Market Cap [USD mil.]	Price-to-Sales	Price-to-Book Value
2007	190 861	3,12	4,41
2008	161 966	2,54	3,81
2009	177 252	2,86	3,50
2010	169 173	2,75	2,99
2011	180 022	2,77	3,15

Source: Author, based on Annual Reports/Market Data (see Appendix)

3.2.7 Merck & Co., Inc.

Merck & Co., Inc. (Merck) is a global health care company with focus on delivering health solutions through its prescription medicines, vaccines, biologic therapies, animal health, and consumer care products. These are marketed both directly as well as through joint ventures. The Company's operations are managed through four key segments: the Pharmaceutical, Animal Health, Consumer Care and Alliances segments. The Pharmaceutical one includes human health pharmaceutical and vaccine products. In December 2011, Merck established an Asia Research & Development headquarters for drug discovery and development situated in Beijing, China. Merck employs approximately 84 thousand individuals (FT, 2012g).

Exhibit 32: Merck – Level of R&D Investments (in millions of USD)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	1 684	23 637	7,12
1998	2 861	26 898	10,63
1999	2 068	32 714	6,32
2000	2 344	40 363	5,81
2001	2 456	47 716	5,15

Source: Author, based on Merck (2002, p.40)

Exhibit 33: Merck – Financials & Profitability (in millions of USD)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	24 198	3 492	3 267	48 351	18 185	7,22	17,97	14,43
2008	23 850	9 931	7 788	47 196	18 758	21,04	41,52	41,64
2009	27 428	15 290	12 853	112 314	59 058	13,61	21,76	55,75
2010	45 987	1 653	859	105 781	54 376	1,56	1,58	3,59
2011	48 047	7 334	6 257	105 128	54 517	6,98	11,48	15,26

Source: Author, based on FT (2012g)

Exhibit 34: Merck – Market Value & Ratios

Year	Market Cap [USD mil.]	Price-to-Sales	Price-to-Book Value
2007	125 825	5,20	6,92
2008	64 074	2,69	3,42
2009	113 834	4,15	1,93
2010	111 114	2,42	2,04
2011	114 759	2,39	2,11

Source: Author, based on Annual Reports/Market Data (see Appendix)

3.2.8 Eli Lilly and Co.

Eli Lilly and Company discovers, develops, manufactures, and markets pharmaceutical products for humans as well as animals. It manufactures and distributes its products through facilities in the United States, Puerto Rico, and 15 other countries. Eli Lilly's products, which include neuroscience, endocrinology, oncology, cardiovascular, animal health products and other pharmaceuticals, are sold in approximately 130 countries worldwide. The Company's new molecular entities, which are in Phase III clinical trial testing, include for instance Dulaglutide, Edivoxetine, Ixekizumab, Necitumumab etc. There are approximately 39 employees working for Eli Lilly and Company (FT, 2012h).

Exhibit 35: Eli Lilly – Level of R&D Investments (in millions of USD)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	1 370	7 988	17,15
1998	1 739	9 237	18,83
1999	1 784	10 003	17,83
2000	2 019	10 862	18,58
2001	2 235	11 543	19,36

Source: Author, based on Eli Lilly (2002, p.33)

Exhibit 36: Eli Lilly – Financials & Profitability (in millions of USD)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	18 634	3 877	2 953	26 875	13 504	14,43	21,87	20,81
2008	20 372	-1 308	-2 072	29 213	6 735	-4,48	-30,76	-6,42
2009	21 836	5 358	4 329	27 461	9 524	19,51	45,45	24,54
2010	23 076	6 525	5 070	31 001	12 420	21,05	40,82	28,28
2011	24 287	5 350	4 348	33 660	13 542	15,89	32,11	22,03

Source: Author, based on FT (2012h)

Exhibit 37: Eli Lilly – Market Value & Ratios

Year	Market Cap [USD mil.]	Price-to-Sales	Price-to-Book Value
2007	60 704	3,26	4,50
2008	46 271	2,27	6,87
2009	41 179	1,89	4,32
2010	40 565	1,76	3,27
2011	48 227	1,99	3,56

Source: Author, based on Annual Reports/Market Data (see Appendix)

3.2.9 Abbott Laboratories

Abbott Laboratories is involved in the process of the discovery, development, manufacture, and sale of wide range of healthcare products. The Company operates in five segments: Proprietary Pharmaceutical Products, Established Pharmaceutical Products, Diagnostic Products, Nutritional Products and Vascular Products. Abbott markets its products globally through its affiliates and distributors. Worldwide, Abbott employs roughly 91 thousand people (FT, 2012i).

Exhibit 38: Abbott – Level of R&D Investments (in millions of USD)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	1 307	11 889	11,00
1998	1 229	12 513	9,82
1999	1 194	13 178	9,06
2000	1 351	13 746	9,83
2001	1 578	16 285	9,69

Source: Author, based on Abbott (2002, pp.56-57)

Exhibit 39: Abbott – Financials & Profitability (in millions of USD)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	25 914	4 579	3 606	39 714	17 779	11,53	20,28	17,67
2008	29 528	5 788	4 881	42 419	17 480	13,64	27,92	19,60
2009	30 765	7 320	5 746	52 582	23 144	13,92	24,83	23,79
2010	35 167	6 088	4 626	60 574	22 677	10,05	20,40	17,31
2011	38 851	5 752	4 728	60 277	24 440	9,54	19,35	14,81

Source: Author, based on FT (2012i)

Exhibit 40: Abbott – Market Value & Ratios

Year	Market Cap [USD mil.]	Price-to-Sales	Price-to-Book Value
2007	86 793	3,35	4,88
2008	82 477	2,79	4,72
2009	83 827	2,72	3,62
2010	74 145	2,11	3,27
2011	88 414	2,28	3,62

Source: Author, based on Annual Reports/Market Data (see Appendix)

3.2.10 Bayer AG

Bayer AG is a German holding company with core business activities in the field of healthcare, nutrition and high-tech materials. Bayer's operations are organized into three subgroups: HealthCare, focused on the research, development and manufacture of health products for humans and animals; CropScience, engaged in the crop protection and non-agricultural pest control; and MaterialScience, providing polymers, and develops solutions for variety of diverse applications. These core operations are supported by the service companies Bayer Business Services, Bayer Technology Services and Currenta. The business operates through numerous subsidiaries, affiliated companies, as well as joint ventures situated in Europe, Latin America, Africa, Middle East, North America, as well as the Asia/Pacific region. Bayer employs approximately 111 thousand individuals globally (FT, 2012j).

Exhibit 41: Bayer – Level of R&D Investments (in millions of EUR)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	1 983	28 124	7,05
1998	2 045	28 062	7,29
1999	2 252	27 320	8,24
2000	2 393	30 971	7,73
2001	2 559	30 275	8,45

Source: Author, based on Bayer (2002, p.109)

Exhibit 42: Bayer – Financials & Profitability (in millions of EUR)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	32 385	3 154	4 711	51 378	16 734	6,14	28,15	9,74
2008	32 918	3 544	1 719	52 511	16 263	6,75	10,57	10,77
2009	31 168	3 006	1 359	51 042	18 897	5,89	7,19	9,64
2010	35 088	2 730	1 301	51 506	18 833	5,30	6,91	7,78
2011	36 528	4 149	2 470	52 765	19 212	7,86	12,86	11,36

Source: Author, based on FT (2012j)

Exhibit 43: Bayer – Market Value & Ratios

Year	Market Cap [EUR mil.]	Price-to-Sales	Price-to-Book Value
2007	47 800	1,48	2,86
2008	31 800	0,97	1,96
2009	46 300	1,49	2,45
2010	45 800	1,31	2,43
2011	40 900	1,12	2,13

Source: Author, based on Bayer (2012, p.50); (2010, p.17); (2009, p.17)

3.2.11 Amgen Inc.

Amgen Inc. is a biotechnology medicines company. It discovers, develops, manufactures and markets medical products, which are focused solely on human therapeutics, specifically on medicines based on cellular and molecular biology. Amgen markets recombinant protein therapeutics in supportive cancer care, inflammation and nephrology. Additionally, it has product candidates in mid- to late-stage development in areas including oncology, hematology, inflammation, bone health, nephrology, cardiovascular and general medicine, neuroscience inclusive. Amgen's staff comprises almost 18 thousand employees (FT, 2012k).

Exhibit 44: Amgen – Level of R&D Investments (in millions of USD)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	631	2 220	28,42
1998	663	2 514	26,38
1999	823	3 043	27,04
2000	845	3 202	26,39
2001	865	3 511	24,64

Source: Author, based on Amgen (2003, pp.2-3)

Exhibit 45: Amgen – Financials & Profitability (in millions of USD)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	14 771	3 980	3 078	34 639	17 869	11,49	17,23	26,94
2008	15 003	5 214	4 052	36 427	20 885	14,31	19,40	34,75
2009	14 642	5 506	4 605	39 629	22 667	13,89	20,32	37,60
2010	15 053	5 545	4 627	43 486	23 944	12,75	19,32	36,84
2011	15 582	4 312	3 683	48 871	19 029	8,82	19,35	27,67

Source: Author, based on FT (2012k)

Exhibit 46: Amgen – Market Value & Ratios

Year	Market Cap [USD mil.]	Price-to-Sales	Price-to-Book Value
2007	50 509	3,42	2,83
2008	59 711	3,98	2,86
2009	55 399	3,78	2,44
2010	51 192	3,40	2,14
2011	50 818	3,26	2,67

Source: Author, based on Annual Reports/Market Data (see Appendix)

3.2.12 Boehringer Ingelheim

Boehringer Ingelheim was founded in 1885 and is headquartered in Ingelheim am Rhein, Germany. It is one of the world's leading pharmaceutical companies, with global operations through 145 affiliates, with more than 44 000 employees. The company engages in the R&D, manufacture, and marketing of pharmaceuticals for human and animal health. Specifically, the Company offers prescription medicines in the fields of benign prostate hyperplasia, cardiovascular disease, chronic obstructive pulmonary disease, diabetes, human immunodeficiency virus/acquired immune deficiency syndrome, hypertension, Parkinson's disease etc. Additionally, Boehringer Ingelheim also offers contract manufacturing services in the areas of biopharmaceuticals, active pharmaceutical ingredients, and finished dosage forms. The Company formed a strategic alliance with Eli Lilly and Company for the joint development and marketing of active substances for diabetes (Bloomberg BusinessWeek, 2012).

It is worth noting that Boehringer Ingelheim is not publically traded on any stock exchange, as it is a privately held company (Clarke, 2012). Therefore, no information regarding the market value ratios will be provided.

Exhibit 47: Boehringer Ingelheim – Level of R&D Investments (in millions of EUR)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	771	4 201	18,35
1998	812	4 474	18,15
1999	826	5 086	16,24
2000	968	6 188	15,64
2001	1 019	6 694	15,22

Source: Author, based on Boehringer Ingelheim (2006, p.120)

Exhibit 48: Boehringer Ingelheim – Financials & Profitability (in millions of EUR)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	10 952	2 100	1 809	10 471	3 372	20,06	53,65	19,17
2008	11 595	1 980	1 424	11 824	4 703	16,75	30,28	17,08
2009	12 721	2 239	1 759	15 004	5 901	14,92	29,81	17,60
2010	12 586	1 896	888	16 233	6 474	11,68	13,72	15,06
2011	13 171	2 272	1 476	18 658	7 466	12,18	19,77	17,25

Source: Author, based on Boehringer Ingelheim (2012, p.94)

3.2.13 Takeda Pharmaceutical Co Ltd

Takeda Pharmaceutical Company Limited is a Japan-headquartered company involved in the three business segments within the pharmaceutical sector. The Ethical Pharmaceutical segment is focused on the manufacturing and sale of specific pharmaceutical products, such as therapeutic substances for diabetes, circulatory drugs, anticancer drugs, medicines for central neurological diseases, digestive system drugs, hormonal agents etc. The Healthcare segment is engaged in production and sale of general drugs and medicines. The Others segment's core business is the manufacturing and sale of reagents, clinical diagnostics and chemical products (FT, 2012-l).

It is worth noting that unlike other presented companies, Takeda Pharmaceuticals' fiscal year ends on March, 31st, and not on December, 31st. This means that for instance for the year 2011, the below figures represent the Company's situation at the date of March, 31st, 2012.

Exhibit 49: Takeda – Level of R&D Investments (in millions of JPY)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	79 039	841 816	9,39
1998	80 034	844 643	9,48
1999	77 260	923 132	8,37
2000	89 846	963 480	9,33
2001	100 278	1 005 060	9,98

Source: Author, based on Takeda (2002, pp.32-33)

Exhibit 50: Takeda – Financials & Profitability (in millions of JPY)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	1 374 802	424 154	355 453	2 849 277	2 280 783	14,89	15,58	30,85
2008	1 538 336	306 468	234 385	2 760 188	2 011 451	11,10	11,65	19,92
2009	1 465 965	420 212	297 745	2 823 272	2 121 338	14,88	14,04	28,66
2010	1 419 385	362 605	247 866	2 786 401	2 091 923	13,01	11,85	25,55
2011	1 508 932	229 304	124 161	3 577 030	2 012 344	6,41	6,17	15,20

Source: Author, based on FT (2012-l)

Exhibit 51: Takeda – Market Value & Ratios

Year	Market Cap [JPY mil.]	Price-to-Sales	Price-to-Book Value
2007	4 288 291	3,12	1,88
2008	2 865 727	1,86	1,42
2009	3 248 229	2,22	1,53
2010	3 082 494	2,17	1,47
2011	2 877 414	1,91	1,43

Source: Author, based on Annual Reports/Market Data (see Appendix)

3.2.14 Bristol-Myers Squibb Co.

Bristol-Myers Squibb Company is a US-headquartered pharmaceutical company, engaged in the discovery, development, licensing, manufacturing, marketing, distribution and sale of biopharmaceutical products. The Company's products are offered worldwide to wholesalers, retail pharmacies, hospitals, government entities and the medical profession. Bristol-Myers manufactures products in the USA, Puerto Rico and in six foreign countries. Regarding the number of employees, approximately 27 thousand people work for this Company worldwide (FT, 2012m).

Exhibit 52: Bristol-Myers – Level of R&D Investments (in millions of USD)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	1 322	13 698	9,65
1998	1 506	15 061	10,00
1999	1 759	16 878	10,42
2000	1 939	18 216	10,64
2001	2 259	19 423	11,63

Source: Author, based on Bristol-Myers (2002, p.48)

Exhibit 53: Bristol-Myers – Financials & Profitability (in millions of USD)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	15 617	2 523	2 158	25 926	10 562	9,73	20,43	16,16
2008	17 715	4 776	5 234	29 486	12 241	16,20	42,76	26,96
2009	18 808	5 602	10 570	31 008	14 843	18,07	71,21	29,79
2010	19 484	6 071	3 102	31 076	15 713	19,54	19,74	31,16
2011	21 244	6 981	3 709	32 970	15 956	21,17	23,25	32,86

Source: Author, based on FT (2012m)

Exhibit 54: Bristol-Myers – Market Value & Ratios

Year	Market Cap [USD mil.]	Price-to-Sales	Price-to-Book Value
2007	52 493	3,36	4,97
2008	46 024	2,60	3,76
2009	43 282	2,30	2,92
2010	45 080	2,31	2,87
2011	59 489	2,80	3,73

Source: Author, based on Annual Reports/Market Data (see Appendix)

3.2.15 Novo Nordisk A/S

Novo Nordisk A/S is a Denmark-based pharmaceutical company. It is involved in the discovery, development, manufacturing and marketing of diverse pharmaceutical products. The Company comprises of two business units: Diabetes and Biopharmaceuticals. Diabetes division offers a range of diabetes products, among others modern insulins such as NovoRapid, NovoMix and Levemir; new-generation insulins as Degludes and DegludecPlus etc. Biopharmaceuticals division provides treatments for patients with haemophilia, growth hormone deficiency and for women experiencing symptoms of menopause. As of December 31, 2011, Novo Nordisk marketed its products in more than 190 countries. Currently, the Company has more than 33 thousand employees worldwide (FT, 2012n).

Exhibit 55: Novo Nordisk – Level of R&D Investments (in millions of DKK)

Year	R&D Expenses	Sales	R&D/Sales [%]
1997	2 190	12 585	17,40
1998	2 798	13 647	20,50
1999	2 748	16 423	16,73
2000	3 390	20 811	16,29
2001	3 970	23 776	16,70

Source: Author, based on Novo Nordisk (2002, p.84)

Exhibit 56: Novo Nordisk – Financials & Profitability (in millions of DKK)

Year	Sales	EBIT	Net Income	Assets	Equity	ROA [%]	ROE [%]	ROS [%]
2007	41 831	8 942	8 522	47 731	32 182	18,73	26,48	21,38
2008	45 553	12 373	9 645	50 603	32 979	24,45	29,25	27,16
2009	51 078	14 933	10 768	54 742	35 734	27,28	30,13	29,24
2010	60 776	18 891	14 403	61 402	36 965	30,77	38,96	31,08
2011	66 346	22 374	17 097	64 698	37 448	34,58	45,66	33,72

Source: Author, based on FT (2012n)

Exhibit 57: Novo Nordisk – Market Value & Ratios

Year	Market Cap [DKK mil.]	Price-to-Sales	Price-to-Book Value
2007	172 000	4,11	5,34
2008	136 000	2,99	4,12
2009	159 000	3,11	4,45
2010	292 000	4,80	7,90
2011	296 000	4,46	7,90

Source: Author, based on Novo Nordisk (2012, p.2); (2010, p.2); (2009, p.2)

3.3 Regression Analysis (Step 4 - 6)

This part will focus on the core of this thesis, which is the examination of the relationship between the R&D expenditures and both profitability as well as market value. This will be achieved by assessing and interpreting the outcomes of the regression analysis.

Firstly, the R&D - profitability link will be scrutinized, followed by the assessment of R&D - market value relation.

3.3.1 R&D - Profitability Link

The above table provides an outline of the data sources for the regression analysis between the degree of research and development, and firms' profitability.

Exhibit 58: R&D - Profitability: Regression Input Data

Company	R&D/Sales (97 - 01)	ROA (07-11)	ROE (07-11)	ROS (07-11)
	13,36	8,05	12,53	19,16
	14,23	8,72	14,08	20,07
Pfizer	14,86	5,01	9,59	21,66
	15,11	4,76	9,40	13,84
	15,03	6,79	12,18	18,93
	11,99	8,99	24,27	17,41
	12,32	11,45	16,30	21,05
Novartis	13,08	10,45	14,64	22,13
	13,01	9,35	15,50	22,35
	13,08	9,36	13,84	18,52
	13,32	24,49	54,30	33,43
	13,87	18,11	58,03	29,30
GlaxoSmithKline	14,14	19,65	55,28	29,69
	13,88	8,96	18,39	13,32
	12,47	19,00	65,50	28,50
...	...	...	...	...
	17,40	18,73	26,48	21,38
	20,50	24,45	29,25	27,16
Novo Nordisk	16,73	27,28	30,13	29,24
	16,29	30,77	38,96	31,08
	16,70	34,58	45,66	33,72

Source: Author

For each company, levels of R&D between years 1997 and 2001, representing the independent variable *x*, as well as ROA, ROE, ROS ratios, considered to be the dependent variables *y*, are provided, in an ascending order. This means that for each company, the ratios in the first upper row correspond to the year 1997 in case of R&D/Sales, or alternatively to 2007 for profitability ratios.

It is worth noting that the data for the remaining set of the companies that are not outlined in the Exhibit 58 can be found in the section *3.2. Selected Companies: Facts & Figures (Step 1 - 3).*

The following table provides an overview of the key statistical measures that were obtained from the MS Excel regression analysis output (for further details, please see Appendix, *5.5 Regression Analysis – MS Excel Outcomes*).

Exhibit 59: R&D - Profitability: Key Statistical Measures

	ROS	ROA	ROE
Regression Equation	y = 0,5328x + 16,3488	y = 0,3401x + 9,7181	y = 0,3913x + 22,0072
P-Value	0,0147	0,0304	0,4200
Coefficient of Determination	0,0788	0,0626	0,0089
Correlation Coefficient	0,2807	0,2501	0,0945

Source: Author

- *R&D - ROS Link*

  For the regression analysis between level of R&D, representing an independent variable, and Return on Sales, as a dependent variable, firstly, the statistical significance of the relationship will be examined.

  As explained in the theoretical part in section *2.3.3 Regression Analysis*, if x and y – in this case level of R&D and Return on Sales – are linearly related, the parameter β_1 in the regression model $y = \beta_0 + \beta_1 x + \varepsilon$ must not equal zero. To examine this, the following hypothesis needs to be tested:

  $H_0: \beta_1 = 0$
  $H_a: \beta_1 \neq 0$

  Also, it has been previously stated that the convenient way of testing the statistical significance of parameter β_1, is to compare so-called p-value, which is part of the Excel's regression analysis output, with a chosen significance level (α) of 5%. The pattern of hypothesis testing is as follows: If $p < \alpha$, the hypothesis H_0 is rejected. On the other side, if $p > \alpha$, the hypothesis H_0 is not rejected, meaning that β_1 equals zero.

  In this specific case, this is the summary of the hypothesis test:

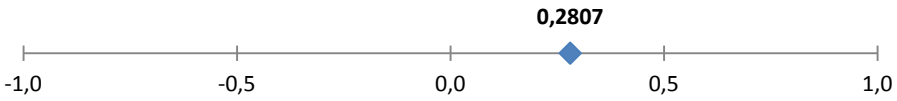
  - P-value (0.0147) < α (0.05)

  Therefore, as the p-value is smaller than 5%, the conclusion that there is a statistically significant relationship between the level of R&D investment and the Return on Sales can be drawn. As significant relationship has been confirmed between these two variables, more specific features of this relationship as well the model will be discussed.

In order to assess the strength of R&D - ROS linear association, the correlation coefficient value needs to be interpreted. In the theoretical part, it has been concluded that the values of the correlation coefficient can vary between -1 and +1. A value of +1 shows that there is a perfectly positive linear relationship between the two variables. A value of -1 indicates that *x* and *y* are also perfectly related, but in a negative linear sense. In case a value of the correlation coefficient is zero, it can be concluded that *x* and *y* are not linearly related.

The correlation coefficient value, resulting from the R&D - ROS regression analysis, is 0.2807. This means that there is somewhat weaker, positive linear link between these two ratios.

Exhibit 60: R&D - ROS: Correlation Coefficient



Source: Author

Finally, the goodness of the model, represented by the coefficient of determination, will be evaluated. As already explained, this coefficient provides information on how well the estimated regression equation fits the actual data. In other words, it measures the proportion of variability in dependent variable, explained by the model.

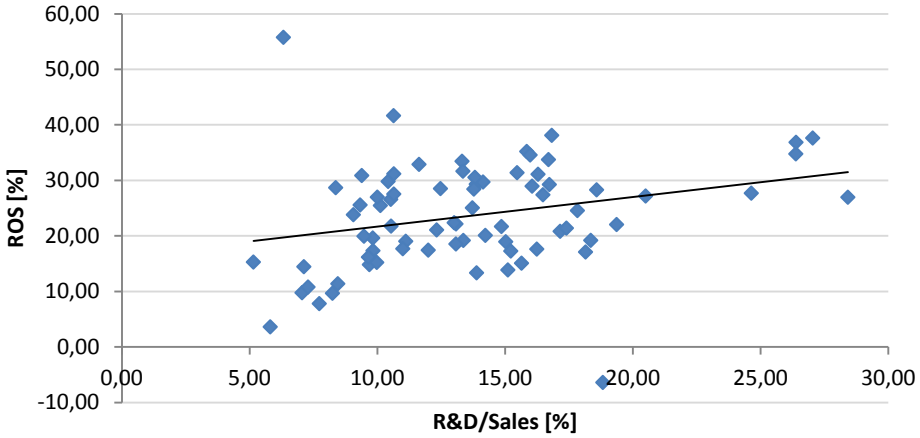
In the context of the regression analysis of the levels of R&D and ROS, the coefficient of determination for the selected sample data set is 0.0788. This suggests, that firms' level of R&D investments explain only about 7.88% of the variation in Return on Sales. Therefore, 92.12% of the ROS variations are left unexplained.

Nevertheless, it is worth noting that this lack of explanatory power is not that surprising. It was not expected that sole R&D expenditures would be a major contributor when explaining the variability in Return on Sales, as there are many other factors that affect this profitability ratio. Inevitably, all these other factors are included in the errors in a simple regression analysis employed in this thesis.

All in all, statistically significant relationship has been identified between the degree of R&D investment and firms' Return on Sales. The direction and strength of the link, based on the value of the correlation coefficient, can be portrayed as linearly positive and rather weaker. Regarding the explanatory power, the model itself explains 7.88% of the variation in the dependent variable, i.e. Return on Sales.

In following exhibit, the graphical overview of the sample data together with the linear regression line, which is in fact the graphical representation of the model, is provided.

Exhibit 61: R&D - ROS: Linear Regression Line



Source: Author

- *R&D - ROA Link*

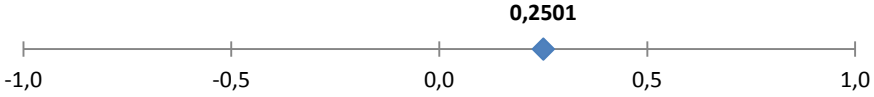
Regarding the regression analysis between the level of R&D expenditures and profitability, represented by the Return on Assets, the p-value of 0.0304 was obtained.

- P-Value (0.0304) < α (0.05)

Due to the fact that the p-value figure is lower than the significance level of 5%, the hypothesis H_0, assuming that β_1 equals zero, is rejected. That is why it can be concluded that there is also a statistically significant relationship between two variables in question.

Concerning the direction as well as strength of R&D - ROA linear association, the correlation coefficient value of 0.2501 resulted from the regression analysis. This value suggests positive, but even slightly weaker link, compared to the R&D - ROS case.

Exhibit 62: R&D - ROA: Correlation Coefficient

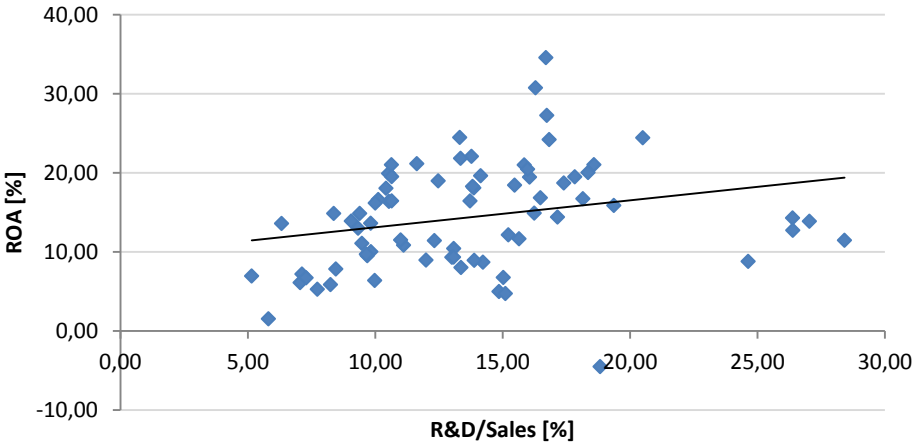


Source: Author

The value of the coefficient of determination of 0.0626 suggests that no more than 6.26% of the variation in the dependent variable - Return on Assets - is actually explained by the independent variable, which is the level of R&D investment.

The below exhibit graphically summarizes the sample data, based on which the linear regression line is plotted.

Exhibit 63: R&D - ROA: Linear Regression Line



Source: Author

- *<u>R&D - ROE Link</u>*

Last ratio of the profitability measures, which dependence on the degree of research and development investments will be examined, is the Return on Equity.

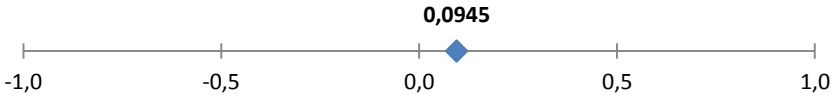
Similarly as in the previous cases, at first place, the statistical significance test of the relationship between the variables under examination will be carried out.

  - P-Value (0.4200) > α (0.05)

Unlike both previously tested hypothesis, this value of p-coefficient means that the hypothesis H_0, assuming that the parameter β_1 equals zero in the in the regression model $y = \beta_0 + \beta_1 x + \varepsilon$, cannot be rejected. In other words, in this particular case, the test suggests that β_1 equals zero, thus the conclusion that there is no linear association between levels of R&D investment and Return on Equity.

What is more, this conclusion is reaffirmed by the correlation coefficient value, which is 0.0945.

Exhibit 64: R&D - ROE: Correlation Coefficient

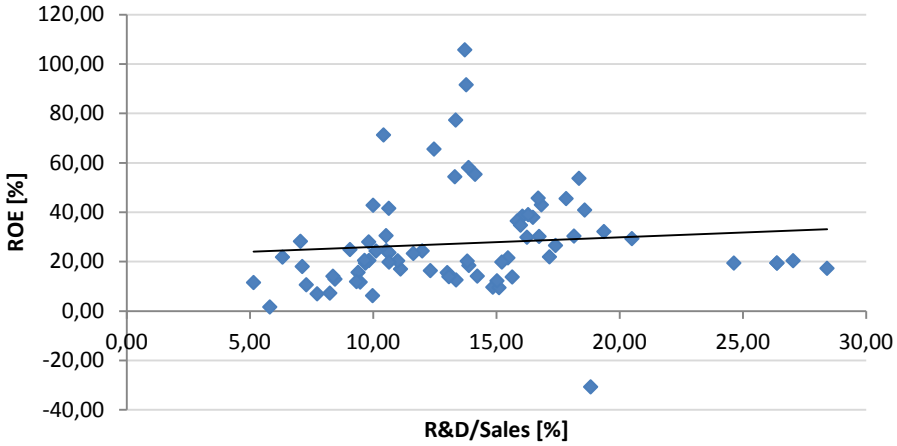


Source: Author

Last but not least, the coefficient of determination, obtained as an outcome of the R&D - ROE regression analysis, reaches the value of 0.0089. This suggests that less than 0.9% of the variation in Return on Equity can be explained by the degree of R&D investment. Such an extremely low value of this coefficient leads to the conclusion that in this case the model is not useful in the context of the R&D - ROE linkage examination.

Below is the chart showing the sample data set for the R&D - ROE regression. The linear regression line is also plotted in the graph. Nevertheless, it is worth emphasizing that this regression line has literally no relevance, as it was concluded that there is no relationship between the variables in question.

Exhibit 65: R&D - ROE: Linear Regression Line



Source: Author

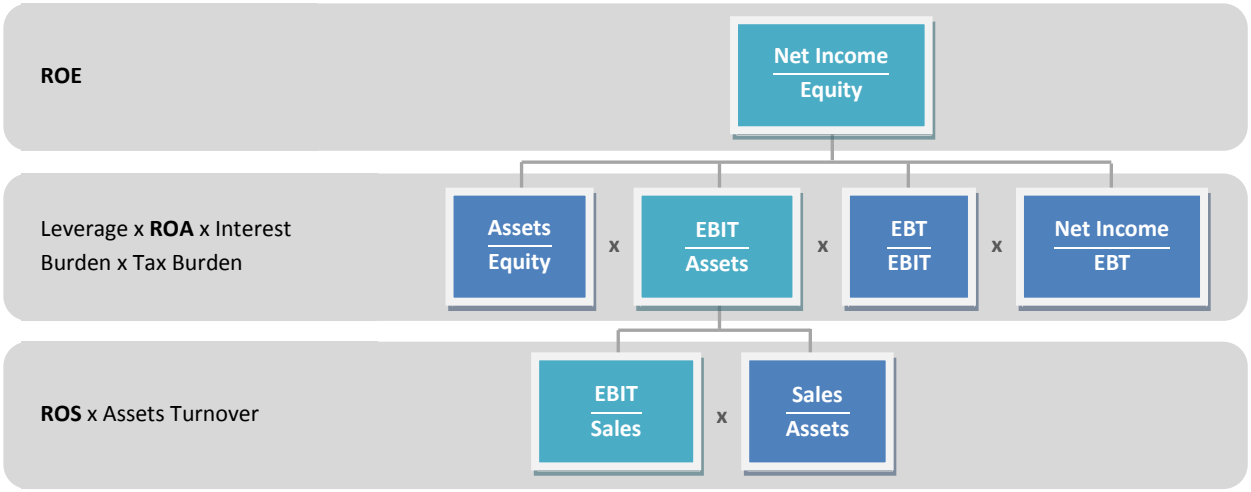
All in all, positive and relatively weak relationships between levels of R&D investment and both Return on Sales and Return on Assets were identified. However, no linear association between R&D and Return on Equity was found. It should not be omitted to emphasize that these results are based on the regression analysis of data gathered from the sample of fifteen pharmaceutical companies. As five inputs per company were collected, there were in total 75 observations for every analysis run.

Prior to moving to the evaluation of link between research and development and market value, it is worth mentioning one interesting finding drawn from this R&D - profitability regression analysis.

Overall, relatively strongest link was found out between R&D and ROS. The association between R&D and ROA was slightly weaker, and finally, no relationship was identified in case of R&D - ROE.

From the perspective of the Du Pont decomposition of Return on Equity, which is shown in the Exhibit 66, these outcomes reflect the underlying logic of such decomposition.

Exhibit 66: Du Pont ROE Decomposition



Source: Author, based on Hnilica (2012)

For the Return on Sales case, which is in the context of Du Pont analysis at the lowest level companred to other two profitability ratios examined, relatively strongest association with R&D levels was concluded, with the correlation coefficient value of 0.2807. In case of Return on Assets though, the correlation coefficient is somewhat lower (0.2501), indicating a weaker link with R&D. From the Du Pont analysis point of view, this makes perfect sense.

In fact, ROS represents solely one factor out of two, that - if multiplied - constitute ROA. Therefore, due to this additional factor, which is the Assets Turnover, the R&D - ROA link is less powerful compared to the R&D - ROS one.

Finally, when moving further up to the Return on Equity ratio, there are additional factors - namely Financial Leverage, Interest Burden and Tax Burden - that influences this measure. This causes that the level of R&D is simply not strong enough to be taken as significant anymore, which means, based on the regression analysis outcome, that there is virtually no relationship between level of R&D and Return on Equity found.

However, it should not be omitted to emphasize that this finding would require further research and analysis of the R&D - profitability link in order to reaffirm this analogy with Du Pont decomposition.

3.3.2 R&D - Market Value Link

In this section of the thesis, the linear association between degree of research and development and market value ratios, namely Price-to-Sales and Price-to-Book Value, will be assessed.

Similarly as previously, first, the source data set for the regression analysis will be outlined. This sample set comprises data from years 1997 till 2001 in case of R&D levels, followed by the market value ratios, lagged by 10 years, for each of the selected companies, except for Boehringer Ingelheim, which is not publically traded, and therefore market value ratios cannot be calculated.

Exhibit 67: R&D - Market Value: Regression Input Data

Company	R&D/Sales (97 - 01)	Price-to-Sales (07-11)	Price-to-Book Value (07-11)
	13,36	3,16	2,36
	14,23	2,46	2,07
Pfizer	14,86	2,97	1,63
	15,11	2,09	1,60
	15,03	2,43	1,99
	11,99	3,18	2,52
	12,32	2,66	2,25
Novartis	13,08	2,75	2,16
	13,01	2,59	2,12
	13,08	2,32	2,09
	13,32	3,08	7,29
	13,87	2,75	8,45
GlaxoSmithKline	14,14	2,43	6,90
	13,88	2,25	7,20
	12,47	2,70	9,21
...	...	...	...
	17,40	4,11	5,34
	20,50	2,99	4,12
Novo Nordisk	16,73	3,11	4,45
	16,29	4,80	7,90
	16,70	4,46	7,90

Source: Author

As in the previous chapter, it is worth noting that the data for the remaining set of the companies that are not comprised in the Exhibit 67 can be found in the section *3.2. Selected Companies: Facts & Figures (Step 1 - 3).*

The following exhibit provides an overview of the key statistical measures that were obtained from the MS Excel regression analysis output (for further details, please see Appendix, *5.5 Regression Analysis – MS Excel Outcomes*).

Exhibit 68: R&D - Market Value: Key Statistical Measures

	Price-to-Sales	Price-to-Book Value
Regression Equation	y = 0,0469x + 2,0664	y = 0,0441x + 3,4777
P-Value	0,0139	0,5462
Coefficient of Determination	0,0858	0,0054
Correlation Coefficient	0,2929	0,0733

Source: Author

- *R&D – Price-to-Sales Link*

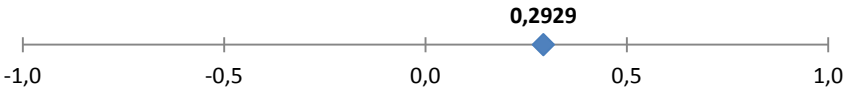
  The p-value for the regression between level of R&D and Price-to-Sales ratio of a given sample data set is 0.0139. In this case, the summary of the hypothesis test is as follows:

  - P-Value (0.0139) < α (0.05)

  This implies that the hypothesis H_0 is rejected, thus it can be stated that there is a significant association between degree of R&D expenses and Price-to-Sales ratio.

  Regarding the strength of this relationship between these two ratios under examination, as the correlation coefficient's value is 0.2929, rather weaker positive link was identified.

Exhibit 69: R&D - Price-to-Sales: Correlation Coefficient



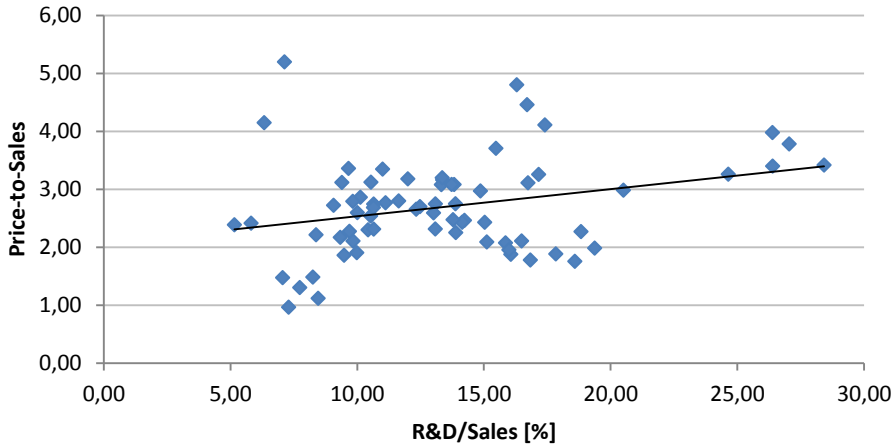
Source: Author

The coefficient of determination of 0.0858 signals that the level of R&D expenditures explains approximately 8.6% of the variation in the Price-to-Sales ratio for the given sample of data. This low explanatory power of the model suggests that the degree of R&D investments is not a major contributor in explaining the variation of the dependant variable – Return-on-Sales.

According to Wooldridge (2009), low values of coefficient of determination (R-squared) are not uncommon in the social sciences context. This author emphasizes that a seemingly low R-squared does not necessarily mean that a regression is useless, which should be borne in mind for this particular case. The major goal of the thesis is not to focus on a prediction based on the regression equation, in which case relatively high values of R-squared are needed. The aim is to see if there is perhaps small but reliable relationship between explanatory and dependent variable. And this relation was in fact confirmed by the t-Test.

Below is the exhibit that graphically sums up the sample data, based on which the linear regression line is plotted.

Exhibit 70: R&D - Price-to-Sales: Linear Regression Line



Source: Author

- *R&D – Price-to-Book Value*

The regression between level of R&D and Price-to-Sales ratio generates the p-value of 0.5462. Therefore, the significance testing is as follows:

  - P-Value (0.5462) > α (0.05)

This implies no linear relation between the two examined variables. This is also confirmed by the value of correlation coefficient.

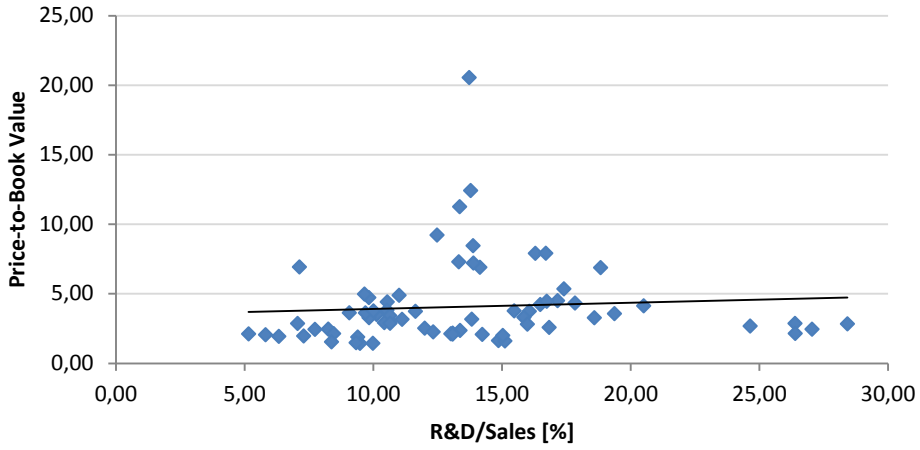
Exhibit 71: R&D - Price-to-Book Value: Correlation Coefficient

Source: Author

Finally, 0.0054 value of the coefficient of determination indicates that the model itself captures almost none of the variation of Price-to-Book Value ratio.

The exhibit 72 concludes graphically the data set as well as the linear regression line of the relation analysis between level of R&D and Price-to-Book Value. However, as previously concluded, there is no linear link identified, which means that any interpretation of the model, represented by the regression line, is irrelevant.

Exhibit 72: R&D - Price-to-Book Value: Linear Regression Line



Source: Author

To conclude, relatively weak but statistically significant positive linear relation was found between the level of R&D expenditures and firm's Price-to-Sales ratio. However, when examining the R&D – Price-to-Book Value ratios, no linear association was identified.

3.4 Business Implications

From the managerial perspective, even though certain degree of dependence was detected between the level of R&D investments and two of the profitability as well as one of the market value ratios, due to its relative weakness, based on the sample data set analysed, it can be concluded that there are rather limited opportunities for increase in pharmaceutical firm's profitability or market value simply by spending larger percentage of sales on research and development.

This conclusion to large degree corresponds with the findings of Booz & Company (2011, p.2). In their report 'The Global Innovation 1000', it is argued that "...spending more on R&D won't drive results." According to this report, entire industries, including pharmaceuticals, "...continue to devote relatively large shares of their resources to innovation, yet end up with much less to show for it than they - and their shareholders - might hope for" (Booz & Company, 2011, p.3).

It is suggested that there are other key factors to be taken into consideration in order to drive results for innovation-focused companies. These comprise for instance strategic alignment of business and innovation strategy, or promotion of corporate culture that to large extent supports innovation (Booz & Company, 2011).

However, it is worth emphasising that this thesis does not intent to question the importance of research and development in the context of the pharmaceutical industry. The author of this thesis is persuaded that in fact "R&D is the lifeblood of the industry", as stated in the report of Deutsche Bank (2003, p.31). Nevertheless, the distinction between the R&D spending, and for instance R&D productivity has to be made.

There is no doubt that increased efficiency of the processes of discovery as well as development of new medicines would, in general, have a significantly positive impact on profitability and market value growth in the long-run. Nevertheless, an increase of the R&D budgets alone seems to be rather insufficient measure to enhance such growth.

3.5 Limitations & Potentials for Further Research

It needs to be emphasized that there are numerous limitations, representing potentials for further improvements or supplementary research. These are some of the major limitations identified:

- Diverse accounting standards / principles of selected companies;
- Non-consideration of mergers and acquisitions (M&A's);
- Companies' involvement in other business areas ignored;
- Extent of sample data set;
- Ten-year lag between R&D and profitability or market value.

Firstly, the regression analysis is based on data gathered from fifteen global pharmaceutical companies. These companies report their financial results in accordance with diverse accounting principles. As the below exhibit shows, firms' financial statements have been prepared in conformity with IFRS, US GAAP as well as other generally accepted accounting principles (GAAP).

Exhibit 73: Accounting Principles of Selected Companies

Company	GAAP: 1997-01 Data	GAAP: 2007-11 Data
Pfizer	US GAAP	US GAAP
Novartis	IAS	IFRS
GlaxoSmithKline	UK GAAP	IFRS
AstraZeneca	UK GAAP	IFRS
Roche	IAS	IFRS
Johnson & Johnson	US GAAP	US GAAP
Merck & Co	US GAAP	US GAAP
Eli Lilly	US GAAP	US GAAP
Abbott	US GAAP	US GAAP
Bayer	IAS	IFRS
Amgen	US GAAP	US GAAP
Boehringer Ingelheim	German GAAP	German GAAP
Takeda	Japanese GAAP	Japanese GAAP
Bristol-Myers	US GAAP	US GAAP
Novo Nordisk	Danish GAAP	IFRS

Source: Author, based on information provided in annual reports

In certain aspects, these accounting principles differ one from each other. These differences can be to large extent explained by the factors as legal and tax systems, the state of economic development, relationships between countries etc. (Porter and Norton, 2010). This implies that these differences are also projected in this thesis' analysis which may to some degree distort the accuracy of the regression model, as well as its interpretation.

However, even if all the selected companies reported in accordance with only one GAAP, there would still be some potential for inaccuracy, as the rules and guidelines might be interpreted in diverse manners. Also, errors or deliberate influencing of accounting figures may occur.

Secondly, in order to enhance growth, apart from focusing solely on internal research and development, pharmaceutical companies might also consider acquiring other businesses with promising R&D pipelines, or alternative outsource certain processes. This kind of external R&D, may also shape profitability or market value, however, this is not captured by the regression model presented in this thesis. This is another limitation to be taken into consideration.

Thirdly, there are companies which business in not focused solely on pharmaceuticals, but there are also divisions engaged in other fields. For instance, Bayer, apart from the HealthCare, incorporates also CropScience and MaterialScience division. This means that the Group consolidated financial statements comprise also results from other non-pharmaceutical areas, which to some extent also distorts the regression analysis outcomes. This represents a potential for further research. If data uniquely from firms' pharmaceutical divisions were collected, the output would be characterised by higher degree of relevance for a given research question.

Fourthly, to reaffirm the conclusions drawn from the simple linear regression analysis between the levels of R&D investment and profitability or market value ratios, higher amount of sample data sets would be required. This is another potential area for further research to be carried out.

Last but not least, for the purpose of this thesis, it was assumed that the investment in R&D positively influences firm's profitability as well as market value in the time horizon of ten years. However, this is an assumption, which represents another limitation of this thesis' research. In order to improve the current state, it would be beneficial to run the regression analysis not only for a ten-year lag, but also for another time spans of for instance eleven or twelve years, and based on the regression analysis outcomes, identify the time lag with the strongest relationships spotted.

4 Conclusion

The aim of this thesis was to examine whether certain degree of relationship exists between the level of pharmaceutical firm's R&D expenditures and its profitability, as well as market value. In order to be able to do so, it was crucial to have a basic understanding of the industry and its research and development specifics. That is why, firstly, the general overview of the pharmaceutical sector was provided, with a particular focus on the R&D process. This was followed by the literature review, where diverse researchers' conclusions, relevant to the research question of this thesis, were outlined. It is worth noting that there was no consensus between these authors regarding the link between R&D and firms' profitability or market value. Some researchers argued that there is no link between these measures, others' findings were in sharp contrast with such conclusions.

In the *Analytical Tools* section, the definitions of specific measures, including R&D, profitability and market ratios, were introduced. After that, the detailed description of the simple linear regression, which was employed in order to examine the relations in question, was presented.

Regarding the practical part, at first place, the six-step model, required for the assessment of the relationship between level of R&D investments and firms' profitability as well as market value, was identified. First step was to define the sample of companies, second to collect all the data needed, third to calculate the R&D, profitability and market value ratios, fourth to run the regression analysis, fifth to interpret its output, and finally the sixth one, to draw the conclusion regarding the relations examined. The steps 1 - 3 were reflected in the section *Selected Companies: Facts & Figures*, where overview of the chosen companies was provided, together with the required data set, comprising the R&D, profitability and market value ratios. The section focusing on the regression analysis, therefore steps 4 – 6, followed.

Based on the regression analysis outcomes, it was concluded that there is statistically significant positive linear relationship between levels of R&D and Return on Sales as well as Return on Assets. However, no significant relation was found between degree of R&D expenses and Return on Equity. What is more, as the association in case of Return on Sales was somewhat stronger compared to the one of Return on Assets, this indicated the parallel with the hierarchical decomposition of so-called Du Pont analysis. The underlying logic is as follows. The strongest link was identified for ROS, which is at the lowest level of the three profitability ratios, as shown by the Exhibit 66. Relatively weaker link was spotted in case of ROA, which is, in fact, a function of ROS. Ultimately, when moving to the top level, represented by the ROE ratio, a function of ROA, as additional factors need to be taken into account, the dependence on R&D was too weak to be affirmed.

Regarding the relationship between levels of R&D expenses and market value ratios, relatively weaker but statistically significant positive linear relation was found in case of Price-to-Sales ratio. However, when examining the levels of R&D investments – Price-to-Book Value ratios, no linear association was identified.

Overall, based on the given sample data set, it was concluded that the degree of R&D expenses can, in a very limited scale, have impact on firms profitability as well as market value, specifically if measured by Return on Sales, Return on Assets or Price-to-Sales. Nevertheless, due to the fact the values of correlation coefficients indicate rather weak strength of these relationships, it was summed up that there are rather limited opportunities for increase of pharmaceutical firm's profitability or market value simply by spending larger percentage of sales on research and development.

Finally, it should not be omitted to mention that numerous limitations of the analysis carried out in this thesis, as well as potentials for further research, were spotted and outlined. Nevertheless, despite all these limitations and potentials for improvement, it is believed that this thesis achieved to meet its aim, and provided insights into whether there is certain degree of association between level of investment in research and development and firms' profitability as well as market value, specifically in the context of the pharmaceutical industry.

5 Appendix

5.1 Reference List

Abbott (2012a) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2011*. [online] Available at: <http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTA0NzQ2OS0xMi0wMDEyMTYvZG9jL0FiYm90dF8xMEtfMjAxMjAyMjEucGRmJnR5cGU9MiZmbj1BYmJvdHRfMTBLXzIwMTIwMjIxLnBkZg==> [Accessed 20/06/2012].

Abbott (2012b) *Historical Price Lookup*. [online] Available at: <http://www.abbottinvestor.com/phoenix.zhtml?c=94004&p=irol-stockLookup> [Accessed 20/06/2012].

Abbott (2011) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2010*. [online] Available at: <http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTA0NzQ2OS0xMS0wMDEwNTYvZG9jL0FiYm90dF8xMEtfMjAxMTAyMTgucGRmJnR5cGU9MiZmbj1BYmJvdHRfMTBLXzIwMTEwMjE4LnBkZg==> [Accessed 20/06/2012].

Abbott (2010) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2009*. [online] Available at: <http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTA0NzQ2OS0xMC0wMDEwMTgvZG9jL0FiYm90dF8xMEtfMjAxMDAyMTkucGRmJnR5cGU9MiZmbj1BYmJvdHRfMTBLXzIwMTAwMjE5LnBkZg==> [Accessed 20/06/2012].

Abbott (2009) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2008*. [online] Available at: <http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTA0NzQ2OS0wOS0wMDE2NDIvZG9jL0FiYm90dF8xMEtfMjAwOTAyMjAucGRmJnR5cGU9MiZmbj1BYmJvdHRfMTBLXzIwMDkwMjIwLnBkZg==> [Accessed 20/06/2012].

Abbott (2008) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2007*. [online] Available at: <http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTA0NzQ2OS0wOC0wMDE0ODAvZG9jL0FiYm90dF8xMEtfMjAwODAyMTkucGRmJnR5cGU9MiZmbj1BYmJvdHRfMTBLXzIwMDgwMjE5LnBkZg==> [Accessed 20/06/2012].

Abbott (2002) *Abbott Laboratories 2001 Annual Report*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2001/1/1/t.aspx?t=XNYS:ABT&ft=&d=e6493736a774f65c> [Accessed 06/07/2012].

Amgen (2012a) *2011 Annual Report and 10-K*. [online] Available at: <http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MTM0MzEzfENoaWxkSUQ9LTF8VHlwZT0z&t=1> [Accessed 20/06/2012].

Amgen (2012b) *Historical Price Lookup.* [online] Available at: <http://investors.amgen.com/phoenix.zhtml?c=61656&p=irol-stockLookup> [Accessed 20/06/2012].

Amgen (2011) *2010 Annual Report and 10-K.* [online] Available at: <http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9NDIwNjg2fENoaWxkSUQ9NDM0MjI1fFR5cGU9MQ==&t=1> [Accessed 20/06/2012].

Amgen (2010) *2009 Annual Report and 10-K.* [online] Available at: <http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MzczNzN8Q2hpbGRJRD0tMXxUeXBlPTM=&t=1> [Accessed 20/06/2012].

Amgen (2009) *2008 Annual Report and 10-K.* [online] Available at: <http://library.corporate-ir.net/library/61/616/61656/items/328987/86751A9B-337F-418C-BF8E-A0C29929BED7_AMGNInvestors2008AnnualReport.pdf> [Accessed 20/06/2012].

Amgen (2008) *2007 Annual Report and 10-K.* [online] Available at: <http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MjAxMTJ8Q2hpbGRJRD0tMXxUeXBlPTM=&t=1> [Accessed 20/06/2012].

Amgen (2003) *Amgen 2002 Annual Report.* [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2002/12/31/t.aspx?t=XNAS:AMGN&ft=&d=c180d063839282c1> [Accessed 20/06/2012].

Anderson, D.R., Sweeney, J.D. and Williams, T.A. (2011) *Essentials of Statistics for Business and Economics*. 6th ed. Mason: South-Western Cengage Learning.

AstraZeneca (2012a) *AstraZeneca Annual Report and Form 20-F Information 2011*. [online] Available at: <http://www.astrazeneca-annualreports.com/2011/documents/pdfs/annual_report_pdf_entire.pdf> [Accessed 24/08/2012].

AstraZeneca (2012b) *Share price lookup*. [online] Available at: <http://www.astrazeneca.com/Investors/Investor-tools/Share-price-lookup> [Accessed 24/08/2012].

AstraZeneca (2002) *AstraZeneca Annual Review 2001*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2001/1/1/t.aspx?t=XLON:AZN&ft=&d=e4585c9b45561063> [Accessed 24/08/2012].

Baker, H.K. and Powell, G.E. (2005) *Understanding Financial Management: A Practical Guide*. Cornwall: Blackwell Publishing.

Bayer (2012) *Bayer Annual Report 2011*. [online] Available at: <http://www.investor.bayer.com/en/downloads/2008-2011/download-20100/> [Accessed 20/06/2012].

Bayer (2010) *Bayer Annual Report 2009.* [online] Available at: <http://www.investor.bayer.com/en/downloads/2008-2011/download-2009/> [Accessed 20/06/2012].

Bayer (2009) *Bayer Annual Report 2008.* [online] Available at: <http://www.investor.bayer.com/en/downloads/2008-2011/download-2008/> [Accessed 20/06/2012].

Bayer (2002) *Bayer Group Financial Report 2001*. [online] Available at: <http://www.investor.bayer.com/no_cache/en/downloads/1998-2002/2001/> [Accessed 06/07/2012].

Bloomberg BusinessWeek (2012) *Company Overview of Boehringer Ingelheim GmbH.* [online] Available at: < http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=6466706> [Accessed 15/11/2012].

Boehringer Ingelheim (2012) *Boehringer Ingelheim Corporate Magazine 2011.* [online] Available at: <http://www.boehringer-ingelheim.com/content/dam/internet/opu/com_EN/document/01_news/08_APC/APC_2012/BoehringerIngelheim_Annual_Report_2011_complete.pdf> [Accessed 20/06/2012].

Boehringer Ingelheim (2006) *Boehringer Ingelheim Annual Report 2005.* [online] Available at: <http://www.boehringer-ingelheim.com/content/dam/internet/opu/com_EN/document/01_news/04_Annual_Report/annualreport05.pdf> [Accessed 20/06/2012].

Booz & Company (2011) *The Global Innovation 1000: Why Culture Is Key.* [online] Available at: <http://www.booz.com/media/uploads/BoozCo-Global-Innovation-1000-2011-Culture-Key.pdf> [Accessed 24/10/2012].

Bragg, S.M. (2002) *Accounting Reference Desktop*. New York: John Wiley and Sons.

Bristol-Myers (2012a) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2011.* [online] Available at: < http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTE5MzEyNS0xMi0wNjY0MTYvZG9jL0JyaXN0b2xNeWVyc1NxdWliYl8xMEtfMjAxMjAyMTcucGRmJnR5cGU9MiZmbj1CcmlzdG9sTXllcnNTcXVpYmJfMTBLXzIwMTIwMjE3LnBkZg==> [Accessed 20/06/2012].

Bristol-Myers (2012b) *Historical Price Lookup.* [online] Available at: <http://www.bms.com/investors/Pages/historical-price-lookup.aspx> [Accessed 20/06/2012].

Bristol-Myers (2011) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2010.* [online] Available at: < http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTE5MzEyNS0xMS0wNDAxMjAvZG9jL0JyaXN0b2xNeWVyc1NxdWliYl8xMEtfMjAxMTAyMTgucGRmJnR5cGU9MiZmbj1CcmlzdG9sTXllcnNTcXVpYmJfMTBLXzIwMTEwMjE4LnBkZg==> [Accessed 20/06/2012].

Bristol-Myers (2010) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2009.* [online] Available at: < http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTE5MzEyNS0xMC0wMzUxNjcvZG9jL0JyaXN0b2xNeWVyc1NxdWliYl8xMEtfMjAxMDAyMTkucGRmJnR5cGU9MiZmbj1CcmlzdG9sTXllcnNTcXVpYmJfMTBLXzIwMTAwMjE5LnBkZg==> [Accessed 20/06/2012].

Bristol-Myers (2009) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2008.* [online] Available at: < http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTE5MzEyNS0wOS0wMzM1MzgvZG9jL0JyaXN0b2xNeWVyc1NxdWliYl8xMEtfMjAwOTAyMjAucGRmJnR5cGU9MiZmbj1CcmlzdG9sTXllcnNTcXVpYmJfMTBLXzIwMDkwMjIwLnBkZg==> [Accessed 20/06/2012].

Bristol-Myers (2008) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2007.* [online] Available at: < http://services.corporate-ir.net/SEC/Document.Service?id=P3VybD1odHRwOi8vaXIuaW50Lndlc3RsYXdidXNpbmVzcy5jb20vZG9jdW1lbnQvdjEvMDAwMTE5MzEyNS0wOC0wMzU1NjYvZG9jL0JyaXN0b2xNeWVyc1NxdWliYl8xMEtfMjAwODAyMjIucGRmJnR5cGU9MiZmbj1CcmlzdG9sTXllcnNTcXVpYmJfMTBLXzIwMDgwMjIyLnBkZg==> [Accessed 20/06/2012].

Bristol-Myers (2002) *Bristol-Myers Squibb Company 2001 Annual Report.* [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2001/1/1/t.aspx?t=XNYS:BMY&ft=&d=4fc2aad035ddd64d> [Accessed 20/06/2012].

Business Wire (2005) Money Doesn't Buy Results - New Innovation Study Finds No Relationship Between R&D Spending and Sales Growth, Earnings, or Shareholder Returns. (2005, Oct 11). *Business Wire,* Available through ProQuest Database at: <http://search.proquest.com/docview/445348625?accountid=17203> [Accessed 16/09/2012].

Chatterjee, S. and Hadi, A.S. (2006) *Regression Analysis by Example*. 4th ed. New Jersey: John Wiley & Sons.

Clarke, T. (2012) Boehringer Ingelheim to start late-stage hepatitis C drug trial. *Reuters* [online] Available at: <http://www.reuters.com/article/2012/11/10/us-liver-boehringer-idUSBRE8A90B820121110> [Accessed 20/08/2012].

Clinton, P. and Cacciotti J. (2012) *Pharm Exec 50: Growth from the Bottom Up.* [online] Available at: <http://www.pharmexec.com/pharmexec/Article/ArticleStandard/Article/detail/772386> [Accessed 05/10/2012].

Damodaran, A. (2011) *Applied Corporate Finance*. 3rd ed. New York: John Wiley & Sons.

Deutsche Bank (2003) *Pharmaceuticals for Beginners: A guide to the pharmaceutical industry.* 2nd ed. London/New York.

Directive 2001/83/EC, of the European Parliament and of the Council of 6 November 2001 on the community code relating to medical products for human use. [online] Available at: <http://www.emea.europa.eu/docs/en_GB/document_library/Regulatory_and_procedural_guideline/2009/10/WC500004481.pdf> [Accessed 04/10/2012].

Eli Lilly (2012a) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2011.* [online] Available at:<http://investor.lilly.com/common/download/download.cfm?companyid=LLY&fileid=548541&filekey=E8FFDA89-5EC1-4D08-AB37-CD85F4C0863D&filename=English.PDF> [Accessed 20/06/2012].

Eli Lilly (2012b) *Historic Stock Lookup.* [online] Available at: <http://investor.lilly.com/stocklookup.cfm> [Accessed 20/06/2012].

Eli Lilly (2011) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2010.* [online] Available at: <http://files.shareholder.com/downloads/LLY/2154702221x0x447905/6281D413-C258-488B-ADBE-B35289495F26/English.PDF> [Accessed 20/06/2012].

Eli Lilly (2010) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2009.* [online] Available at:<http://investor.lilly.com/common/download/download.cfm?companyid=LLY&fileid=357090&filekey=99D528C9-E7DF-48E2-99B0-8D4FA2403BE8&filename=English.PDF> [Accessed 20/06/2012].

Eli Lilly (2009) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2008.* [online] Available at: <http://investor.lilly.com/common/download/sec.cfm?companyid=LLY&fid=950152-09-1897&cik=59478> [Accessed 20/06/2012].

Eli Lilly (2008) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2007.* [online] Available at: <http://media.corporate-ir.net/media_files/irol/73/73184/Eli Lilly%2010-K%202007%20final.pdf> [Accessed 20/06/2012].

Eli Lilly (2002) *Eli Lilly and Company Annual Report 2001*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2001/1/1/t.aspx?t=XNYS:LLY&ft=&d=bb6fcc40c91ac3c7> [Accessed 06/07/2012].

Estrada, J. (2005) *Finance in a Nutshell: A No-nonsense Compilation to the Tools and Techniques of Finance*. London: Pearson Education Limited.

Fernández, P. (2002) *Valuation Methods and Shareholder Value Creation*. London: Academic Press.

FT (2012a) *Pfizer Inc*. [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=PFE:NYQ&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012b) *Novartis AG.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=NOVN:VTX&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012c) *GlaxoSmithKline PLC.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=GSK:LSE&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012d) *AstraZeneca PLC.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=AZN:LSE&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012e) *Roche Holding AG.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=ROG:VTX&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012f) *Johnson & Johnson.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=JNJ:NYQ&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012g) *Merck & Co Inc.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=MRK:NYQ&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012h) *Eli Lilly and Co.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=LLY:NYQ&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012i) *Abbott Laboratories.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=ABT:NYQ&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012j) *Bayer AG.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=BAYX.N:GER&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012k) *Amgen Inc.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=AMGN:NSQ&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012-l) *Takeda Pharmaceutical Co Ltd.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=4502:TYO&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012m) *Bristol-Myers Squibb Co.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=BMY:NYQ&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012n) *Novo Nordisk A/S.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Financials?s=NOVO+B:CPH&subview=IncomeStatement> [Accessed 20/06/2012].

FT (2012o) *Teva Pharmaceutical Industries Ltd.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Business-profile?s=TEVA:NYQ> [Accessed 20/06/2012].

FT (2012p) *Schering Plough Indonesia Tbk PT.* [online] Available at: <http://markets.ft.com/research/Markets/Tearsheets/Business-profile?s=SCPI:JKT> [Accessed 20/06/2012].

Gallagher, T.J. and Andrew, J.D. (2007) *Financial Management: Principles and Practice*. 4th ed. USA: Freeload Press.

Gitman, L.J. and McDaniel, C. (2009) *The Future of Business: The Essentials.* 4th ed. Mason: South-Western.

GSK (2012) *GlaxoSmithKline Annual Report 2011*. [online] Available at: <http://www.gsk.com/content/dam/gsk/globals/documents/pdf/GSK-Annual-Report-2011.pdf> [Accessed 06/07/2012].

GSK (2011) *GlaxoSmithKline Annual Report 2010*. [online] Available at: <http://www.gsk.com/content/dam/gsk/globals/documents/pdf/GSK-Annual-Report-2010.pdf> [Accessed 06/07/2012].

GSK (2010) *GlaxoSmithKline Annual Report 2009*. [online] Available at: <http://www.gsk.com/content/dam/gsk/globals/documents/pdf/GSK-Report-2009-full.pdf> [Accessed 06/07/2012].

GSK (2009) *GlaxoSmithKline Annual Report 2008*. [online] Available at: <http://www.gsk.com/content/dam/gsk/globals/documents/pdf/GSK-Report-2008-full.pdf> [Accessed 06/07/2012].

GSK (2008) *GlaxoSmithKline Annual Report 2007*. [online] Available at: <http://www.gsk.com/content/dam/gsk/globals/documents/pdf/annual-report-2007.pdf> [Accessed 06/07/2012].

GSK (2002) *GlaxoSmithKline Annual Report 2001*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2001/1/1/t.aspx?t=XLON:GSK&ft=&d=d825e12475a3556d> [Accessed 06/07/2012].

Hajiheydari, A., Dastgir, M., and Soltani, A. (2011) The Effect of Research and Development Costs on the Profitability of Pharmaceutical Companies. *Interdisciplinary Journal of Contemporary Research in Business* [e-journal] 3(8), 914-918. Available through ProQuest Database at: <http://search.proquest.com/docview/928449920?accountid=17203> [Accessed 02/09/2012].

Hanel, P. and St-Pierre, A. (2002) Effects of R&D Spillovers on the Profitability of Firms. *Review of Industrial Organization* [e-journal] 20(4), 305-322. Available through ProQuest Database at: <http://search.proquest.com/docview/209875716?accountid=17203> [Accessed 15/09/2012].

Hnilica, J. (2012) Financial Statement Analysis, *3PE671 Corporate Finance*. University of Economics, Prague.

Ike, C.E. and Olibe, K. (2010) The Effect of R&D Investment on Firm Value: An Examination of US Manufacturing and Service Industries. *International Journal of Production Economics* [e-journal] 128(1), 127, Abstract only. Available through ProQuest Database at: <http://search.proquest.com/docview/759068748?accountid=17203> [Accessed 02/09/2012].

IMAP (2011) *An IMAP Healthcare Report: Pharmaceuticals & Biotech Industry Global Report – 2011*. [online] Available at: <http://www.imap.com/imap/media/resources/IMAP_PharmaReport_8_272B8752E0FB3.pdf> [Accessed 14/09/2012].

Johnson & Johnson (2012) *FORM 10-K Annual Report - Fiscal Year Ended 01/01/12.* [online] Available at: <http://files.shareholder.com/downloads/JNJ/2154623867x0xS1193125-12-75565/200406/filing.pdf> [Accessed 20/06/2012].

Johnson & Johnson (2011) *FORM 10-K Annual Report - Fiscal Year Ended 01/02/11.* [online] Available at: <http://files.shareholder.com/downloads/JNJ/2154623867x0xS950123-11-18128/200406/filing.pdf> [Accessed 20/06/2012].

Johnson & Johnson (2010) *FORM 10-K Annual Report - Fiscal Year Ended 01/03/10.* [online] Available at: <http://files.shareholder.com/downloads/JNJ/2154623867x0xS950123-10-19392/200406/filing.pdf> [Accessed 20/06/2012].

Johnson & Johnson (2009) *FORM 10-K Annual Report - Fiscal Year Ended 12/28/08.* [online] Available at: <http://files.shareholder.com/downloads/JNJ/2154623867x0xS950123-09-3187/200406/filing.pdf> [Accessed 20/06/2012].

Johnson & Johnson (2008) *FORM 10-K Annual Report - Fiscal Year Ended 12/30/07.* [online] Available at: <http://files.shareholder.com/downloads/JNJ/2154623867x0xS950123-08-2130/200406/filing.pdf> [Accessed 20/06/2012].

Johnson & Johnson (2003) *Johnson & Johnson 2002 Annual Report*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2002/12/29/t.aspx?t=XNYS:JNJ&ft=&d=22a8042c46098c6a> [Accessed 06/07/2012].

Kislingerová et al. (2007) *Manažerské finance,* 2nd ed. Prague: C.H. Beck.

Koku, P.S. (2010) R&D Expenditure and Profitability in the Pharmaceutical Industry in the United States. *Journal of Applied Management Accounting Research.* [e-journal] 8(1), 35-42. Available through ProQuest Database at: <http://search.proquest.com/docview/609345132?accountid=17203> [Accessed 20/09/2012].

Merck (2012a) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2011.* [online] Available at: <http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MTI4NDM5fENoaWxkSUQ9LTF8VHlwZT0z&t=1> [Accessed 20/06/2012].

Merck (2012b) *Historic Price Lookup.* [online] Available at: <http://www.merck.com/investors/financials/stock-information/historical-price-lookup.html> [Accessed 20/06/2012].

Merck (2011) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2010.* [online] Available at: <http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9ODM1MDV8Q2hpbGRJRD0tMXxUeXBlPTM=&t=1> [Accessed 20/06/2012].

Merck (2010) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2009.* [online] Available at: <http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9MzcxMDk4fENoaWxkSUQ9MzY4MDQ2fFR5cGU9MQ==&t=1> [Accessed 20/06/2012].

Merck (2009) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2008.* [online] Available at: <http://media.corporate-ir.net/media_files/irol/73/73184/MRKForm10K2008final.pdf> [Accessed 20/06/2012].

Merck (2008) *FORM 10-K Annual Report - Fiscal Year Ended December 31, 2007.* [online] Available at: <http://media.corporate-ir.net/media_files/irol/73/73184/Merck%2010-K%202007%20final.pdf> [Accessed 20/06/2012].

Merck (2002) *Merck & Co., Inc. 2001 Annual Report*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2001/1/1/t.aspx?t=XNYS:MRK&ft=&d=79fd3566552cd081> [Accessed 06/07/2012].

Nord, L.J. (2011) R&D Investment Link to Profitability: A Pharmaceutical Industry Evaluation. *Undergraduate Economic Review* [e-journal] 8(1), Article 6. Available at: <http://digitalcommons.iwu.edu/uer/vol8/iss1/6> [Accessed 02/10/2012].

Novartis (2012) *Novartis 2011 Annual Report*. [online] Available at: <http://www.novartis.com/downloads/investors/reports/novartis-annual-report-2011-en.pdf> [Accessed 06/07/2012].

Novartis (2010) *Novartis 2009 Annual Report*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-

Report/2009/12/31/t.aspx?t=XNYS:NVS&ft=&d=66d230f9d81f0d2804e54631b16cc614> [Accessed 06/07/2012].

Novartis (2009) *Novartis 2008 Annual Report*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2008/12/31/t.aspx?t=XNYS:NVS&ft=&d=69572d07335f3bc3> [Accessed 06/07/2012].

Novartis (2002) *Novartis 2001 Annual Report*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2001/1/1/t.aspx?t=XNYS:NVS&ft=&d=ee48e96e32cf4d28> [Accessed 06/07/2012].

Novo Nordisk (2012) *Novo Nordisk Annual Report 2011.* [online] Available at: <http://webmedia.novonordisk.com/nncom/images/annual_report/2011/Novo-Nordisk-AR-2011-en.pdf> [Accessed 20/06/2012].

Novo Nordisk (2010) *Novo Nordisk Annual Report 2009.* [online] Available at: <http://www.novonordisk.com/images/annual_report/2009/Novo-Nordisk-AR-2009-en.pdf> [Accessed 20/06/2012].

Novo Nordisk (2009) *Novo Nordisk Annual Report 2008.* [online] Available at: <http://www.novonordisk.com/images/annual_report/AR_08/Novo_Nordisk_UK_AR2008.pdf> [Accessed 20/06/2012].

Pfizer (2012a) *Pfizer Investor Relations: The Investor Dashboard.* [online] Available at: <http://www.pfizer.com/investors/shareholder_services/investor_dashboard.jsp?t=3> [Accessed 20/06/2012].

Pfizer (2012b) *Pfizer Annual Review 2011*. [online] Available at: <http://www.pfizer.com/files/annualreport/2011/pfizer_11ar_entire_site.pdf> [Accessed 20/06/2012].

Pfizer (2010) *Pfizer Annual Review 2009.* [online] Available at: <http://www.pfizer.com/files/annualreport/2009/annual/review2009.pdf> [Accessed 20/06/2012].

Pfizer (2002) *Pfizer Annual Report 2001*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2001/1/1/t.aspx?t=XNYS:PFE&ft=&d=e477ce5c99db0c46> [Accessed 06/07/2012].

PhRMA (2007) *Drug Discovery and Development: Understanding the R&D Process*. [online] Available at: <http://www.innovation.org/drug_discovery/objects/pdf/RD_Brochure.pdf> [Accessed 20/09/2012].

Porter, G.A. and Norton, C.L. (2010) *Financial Accounting: The Impact on Decision Makers*, 7th ed. Mason: South-Western Cengage Learning.

Reuters (2010) *FACTBOX-The 20 largest pharmaceutical companies.* [online], 26 March 2010. Available at: <http://www.reuters.com/article/2010/03/26/pharmaceutical-mergers-idUSN2612865020100326> [Accessed 14/08/2012].

Reuters (2009) *Merck, Schering-Plough set to complete merger.* [online], 03 November 2009. Available at: <http://www.reuters.com/article/2009/11/03/us-merck-scheringplough-idUSTRE5A23YZ20091103> [Accessed 16/10/2012].

Roche (2012) *Roche 2011 Finance Report*. [online] Available at: <http://www.roche.com/fb11e.pdf> [Accessed 06/07/2012].

Roche (2002) *Roche 2001 Annual Report*. [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2001/1/1/t.aspx?t=PINX:RHHVF&ft=&d=c19324431edbb978> [Accessed 06/07/2012].

Russell Investments (2012) *Russell Investment Glossary - Correlation Coefficient.* [image online] Available at: <http://www.russell.com/us/investment-glossary/index.aspx?term=Correlation+Coefficient> [Accessed 24/11/2012].

Takeda (2012) *Annual Report 2012.* [online] Available at: <http://www.takeda.com/pdf/usr/default/ar2012e_47422_6.pdf> [Accessed 20/06/2012].

Takeda (2009) *Annual Report 2009.* [online] Available at: <http://www.takeda.com/pdf/usr/default/ar2009e_35417_1.pdf> [Accessed 20/06/2012].

Takeda (2002) *Takeda Annual Report 2002.* [online] Available at: <http://quote.morningstar.com/stock-filing/Annual-Report/2002/3/31/t.aspx?t=PINX:TKPYY&ft=&d=64327390465c976d> [Accessed 20/06/2012].

Vernimmen, P., Quiry, P., Le Fur, Y, Salvi, A. and Dallochio, M. (2011) *Corporate Finance: Theory and Practice*. 3rd ed. Chichester: John Wiley & Sons.

Wooldridge, J.M. (2009) Introductory Econometrics: A Modern Approach, 4th ed. Mason: South-Western Cengage Learning.

5.2 List of Exhibits

5.3 Market Definitions

Exhibit 74: Market Definitions

United States of America	Other Established Markets		Emerging Markets		
US	**Western Europe**	**Japan**	**Emerging Europe**	**China**	**Other Emerging ROW**
	Austria		Albania*		Egypt
	Belgium	**Canada**	Belarus*	**Emerging Asia Pacific**	Gulf States
	Denmark		Bosnia and Herzegovina	Bangladesh*	Israel*
	Finland	**Other Established ROW**	Bulgaria	Cambodia*	Latin America
	France	Australia	Croatia	Hong Kong	Lebanon*
	Germany	New Zealand	Czech Republic	India	Maghreb
	Greece		Estonia*	Indonesia*	Saudi Arabia
	Iceland*		Georgia*	Laos*	South Africa
	Ireland		Hungary	Malaysia	
	Italy		Kazakhstan*	Philippines	
	Luxembourg*		Latvia*	Singapore	
	Netherlands		Lithuania*	South Korea	
	Norway		Macedonia*	Sri Lanka*	
	Portugal		Poland	Taiwan	
	Spain		Romania*	Thailand	
	Sweden		Russia	Vietnam*	
	Switzerland		Serbia and Montenegro*		
	UK		Slovakia		
			Slovenia*		
			Turkey		
			Ukraine*		

Rest of World means Other Established Markets and Emerging Markets.
Established Markets means the US and Other Established Markets.
Established ROW means Canada, Japan and Other Established ROW.
Latin America includes Argentina, Brazil, Chile, Colombia, Costa Rica*, El Salvador*, Guatemala*, Honduras*, Mexico, Nicaragua*, Panama*, Peru* and Venezuela.
Gulf States includes Bahrain*, Dubai*, Kuwait*, Oman*, Qatar* and UAE.
Maghreb means Algeria, Morocco and Tunisia*.
*IMS Health, IMS Midas Quantum Q3 2011 data is not available or AstraZeneca does not subscribe for IMS Health quarterly data for these countries.

Source: AstraZeneca (2012a, p.209)

5.4 Market Cap - Sources

Exhibit 75: Pfizer – Market Cap Calculation

Year	Common Shares Outstanding [PCS mil.]	Year-End Share Price [USD]	Market Cap [USD mil.]
2007	6 737	22,73	153 132
2008	6 722	17,71	119 047
2009	8 051	18,19	146 448
2010	8 012	17,51	140 290
2011	7 575	21,64	163 923

Source: Pfizer (2012a); (2012b, p.9); (2010, p.24)

Exhibit 76: AstraZeneca – Market Cap Calculation

Year	Common Shares Outstanding [PCS mil.]	Year-End Share Price [USD]	Market Cap [USD mil.]
2007	1 457	42,80	62 360
2008	1447	41,03	59 370
2009	1451	46,94	68 110
2010	1409	46,19	65 082
2011	1292	46,29	59 807

Source: AstraZeneca (2012a, p.203); (2012b)

Exhibit 77: Johnson & Johnson – Market Cap Calculation

Year	Common Shares Outstanding [PCS mil.]	Year-End Share Price [USD]	Market Cap [USD mil.]
2007	2 833	67,38	190 861
2008	2 766	58,56	161 966
2009	2 752	64,41	177 252
2010	2 735	61,85	169 173
2011	2 745	65,58	180 022

Source: Johnson & Johnson (2012, p.2, 107); (2011, p.2); (2010, p.3); (2009, p.3); (2008, p.3)

Exhibit 78: Merck – Market Cap Calculation

Year	Common Shares Outstanding [PCS mil.]	Year-End Share Price [USD]	Market Cap [USD mil.]
2007	2 165	58,11	125 825
2008	2 108	30,40	64 074
2009	3 115	36,54	113 834
2010	3 083	36,04	111 114
2011	3 044	37,70	114 759

Source: Merck (2012a, p.1); (2012b); (2011, p.1); (2010, p.1); (2009, p.3); (2008, p.3)

Exhibit 79: Eli Lilly – Market Cap Calculation

Year	Common Shares Outstanding [PCS mil.]	Year-End Share Price [USD]	Market Cap [USD mil.]
2007	1 137	53,39	60 704
2008	1 149	40,27	46 271
2009	1 153	35,71	41 179
2010	1 158	35,04	40 565
2011	1 160	41,56	48 227

Source: Eli Lilly (2012a, p.15); (2012b); (2011, p.13); (2010, p.13); (2009, p.2); (2008, p.3)

Exhibit 80: Abbott – Market Cap Calculation

Year	Common Shares Outstanding [PCS mil.]	Year-End Share Price [USD]	Market Cap [USD mil.]
2007	1 546	56,15	86 793
2008	1 545	53,37	82 477
2009	1 553	53,99	83 827
2010	1 548	47,91	74 145
2011	1 572	56,23	88 414

Source: Abbott (2012a, p.3); (2012b); (2011, p.3); (2010, p.3); (2009, p.3); (2008, p.2)

Exhibit 81: Amgen – Market Cap Calculation

Year	Common Shares Outstanding [PCS mil.]	Year-End Share Price [USD]	Market Cap [USD mil.]
2007	1 088	46,44	50 509
2008	1 034	57,75	59 711
2009	979	56,57	55 399
2010	932	54,90	51 192
2011	791	64,21	50 818

Source: Amgen (2012a, p.15); (2012b); (2011, p.15); (2010, p.11); (2009, p.13); (2008, p.11)

Exhibit 82: Takeda – Market Cap Calculation

Year	Common Shares Outstanding [PCS mil.]	Year-End Share Price [JPY]	Market Cap [JPY mil.]
2007	859	4 990,00	4 288 291
2008	843	3 400,00	2 865 727
2009	789	4 115,00	3 248 229
2010	789	3 905,00	3 082 494
2011	789	3 645,00	2 877 414

Source: Takeda (2012, p.97); (2009, p.107); FT (2012-l)

Exhibit 83: Bristol-Myers – Market Cap Calculation

Year	Common Shares Outstanding [PCS mil.]	Year-End Share Price [USD]	Market Cap [USD mil.]
2007	1 979	26,52	52 493
2008	1 980	23,25	46 024
2009	1 714	25,25	43 282
2010	1 702	26,48	45 080
2011	1 688	35,24	59 489

Source: Bristol-Myers (2012a, p.3); (2012b); (2011, p.3); (2010, p.2); (2009, p.2); (2008, p.2)

5.5 Regression Analysis – MS Excel Outcomes

5.5.1 R&D – Return on Sales

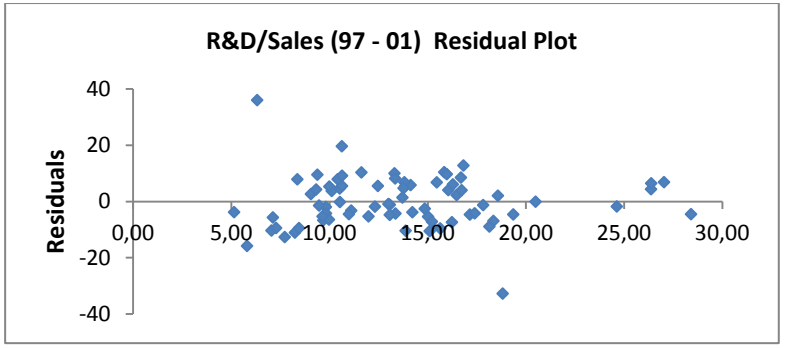
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,280703135
R Square	0,07879425
Adjusted R Square	0,066174993
Standard Error	9,128257271
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	520,2792305	520,2792305	6,243969108	0,014712006
Residual	73	6082,730899	83,3250808		
Total	74	6603,010129			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	16,34880492	3,101373423	5,271472567	1,32211E-06	10,1677766	22,52983324	10,1677766	22,52983324
R&D/Sales (97 - 01)	0,532823371	0,213232252	2,498793531	0,014712006	0,107852106	0,957794635	0,107852106	0,957794635



5.5.2 R&D – Return on Assets

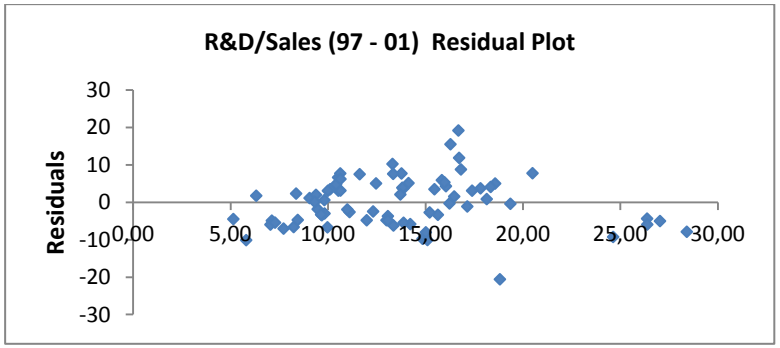
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,250134077
R Square	0,062567056
Adjusted R Square	0,049725509
Standard Error	6,596854118
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	212,0323524	212,0323524	4,872236615	0,030435673
Residual	73	3176,84935	43,51848425		
Total	74	3388,881703			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	9,718123955	2,241315886	4,335901073	4,57587E-05	5,251187836	14,18506007	5,251187836	14,18506007
R&D/Sales (97 - 01)	0,340146563	0,154099738	2,207314344	0,030435673	0,033026227	0,647266898	0,033026227	0,647266898



5.5.3 R&D – Return on Equity

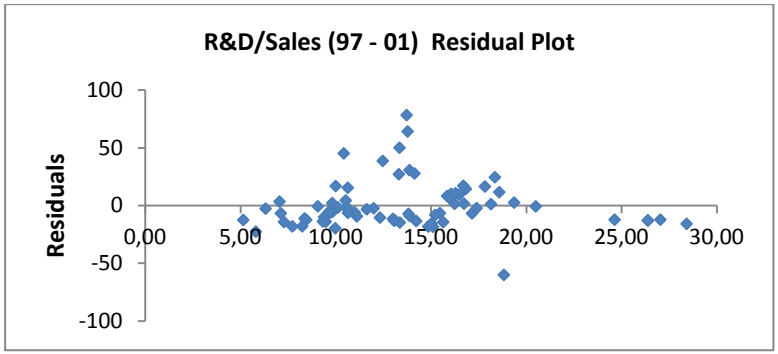
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,094503098
R Square	0,008930835
Adjusted R Square	-0,004645454
Standard Error	20,6544594
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	280,6329422	280,6329422	0,657825925	0,419965055
Residual	73	31142,28859	426,606693		
Total	74	31422,92153			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	22,00721006	7,017461224	3,136064363	0,002468009	8,021430014	35,99299011	8,021430014	35,99299011
R&D/Sales (97 - 01)	0,391322073	0,482479487	0,811064686	0,419965055	-0,570258157	1,352902303	-0,570258157	1,352902303



5.5.4 R&D – Price-to-Sales

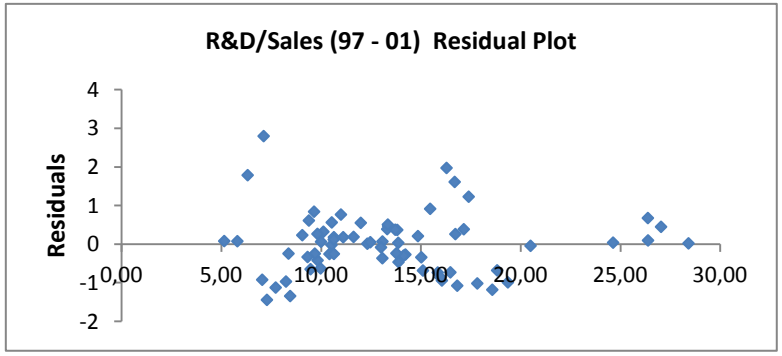
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,292944285
R Square	0,085816354
Adjusted R Square	0,072372477
Standard Error	0,781473309
Observations	70

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3,898287112	3,898287112	6,383303933	0,013852392
Residual	68	41,52763622	0,610700533		
Total	69	45,42592333			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	2,066446049	0,266613734	7,750711191	6,21434E-11	1,534426627	2,598465471	1,534426627	2,598465471
R&D/Sales (97 - 01)	0,046868227	0,018550506	2,526520123	0,013852392	0,009851268	0,083885186	0,009851268	0,083885186



5.5.5 R&D – Price-to-Book Value

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,073342387
R Square	0,005379106
Adjusted R Square	-0,009247672
Standard Error	3,060073473
Observations	70

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3,443698522	3,443698522	0,367757396	0,546248496
Residual	68	636,7553769	9,36404966		
Total	69	640,1990754			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	3,477656865	1,043999334	3,331091077	0,001401128	1,39438863	5,5609251	1,39438863	5,5609251
R&D/Sales (97 - 01)	0,044050838	0,072639604	0,606430042	0,546248496	-0,100899235	0,189000911	-0,100899235	0,189000911