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The role of research & development within pharmaceutical mergers & acquisitions in OECD countries

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Key abbreviations

- M&A – Mergers and acquisitions
- R&D – Research and development
- Acquiror – The company initiating a merger or acquisition
- Target – The firm that is being acquired
- NCE – New chemical entity
- CAR – Cumulative abnormal return
- OECD – Organization for Economic Co-operation and Development

Executive summary

In this thesis, the relationship between research & development, intellectual property and mergers & acquisitions is explored within the pharmaceutical industry in developed economies. M&A forms a double-edged sword within the paradigm of value creation in medicine, as it can serve to foster innovation through economies of scale and scope, whilst simultaneously reducing competition. This thesis aims to determine an appropriate M&A strategy for pharmaceutical firms, and provide regulators with a point of reference for determining anti-trust policy. This is especially relevant in a time where R&D costs are rising, and pharmaceutical solutions to global issues are more needed than ever.

Using cumulative abnormal returns as a proxy for M&A value creation, it has been discovered that target returns correlate positively with target R&D intensity, and with an interaction between target R&D intensity and acquiror sales. This relationship is not reflected in acquiror returns, which implies that generally, acquirors are overpaying for these items. Acquiror returns are negatively correlated with acquiror R&D intensity, and are positively correlated to acquiror's intellectual property. This indicates that acquirors who are not generating new patents are more likely to benefit from M&A activity. Hence, acquirors are still paying for target R&D intensity in some instances. Furthermore, since acquirors with more intellectual property relative to their total assets are more successful, some acquirors may benefit from protecting their current patents from potential competitors. More importantly, economies of scope in M&A are more easily realized when a firm has more intellectual property, leading to a more efficient drug development process. The findings of this thesis are therefore positive overall.

On average, acquirors realize negative returns on announcement, indicating that there is no one-size-fits-all solution. Elements discussed in this thesis can be used as guidelines, which have to be adjusted on a case-by-case basis to realize a successful M&A deal. Finally, regulators may consider these characteristics to unearth a socially desirable equilibrium between innovation and anti-trust concerns, that can serve as a blueprint for a regulatory framework.

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1. Introduction

1.1 Research purpose

The pharmaceutical industry is fundamental to the functioning of modern society by creating life-saving drugs through research and development, and generated over $1.2 trillion of revenues in 2019 (Statista, 2020). It is a constantly evolving sector, often drawing the ire of the public for its pricing practices (Kuchler, 2019). Mergers and acquisitions play a prominent role in this industry, as firms constantly seek ways to improve shareholder returns when organic growth dries up. But is M&A a valid pathway to value creation in the pharmaceutical industry? And what role does R&D play in this? The principal question that must be answered is:

What is the role of research & development within pharmaceutical mergers & acquisitions in OECD countries?

1.2 Structure

To answer this question, a holistic overview of value creation in pharmaceutical M&A will be provided. First, a light will be shed on the manner in which the pharmaceutical industry operates. Then, the role that M&A plays in the value creation paradigm will become clear by considering what M&A entails, both in general and in the pharmaceutical industry. Furthermore, certain concepts such as the efficient market hypothesis and the drug development process will be explained to provide the reader with a coherent understanding of discussed topics. Finally, five hypotheses will be stated. After creating a theoretical framework, the data selection process will be outlined and a dataset on pharmaceutical M&A in OECD countries is obtained. Furthermore, research methodology will be explained. When it is decided how the research will be conducted, results are obtained and interpreted, which can answer the hypotheses. In conjunction with literature, it then becomes possible to answer the research question.

1.3 Scientific relevance

Pharmaceutical firms assert that mergers and acquisitions are beneficial through synergies in research and development, vertical integration or geographic reach (Bansal et al., 2020). One example of a successful merger is Novartis, a Swiss pharmaceutical firm that was formed by a $30 billion merger between Sandoz and Ciba-Geigy in 1996. In Novartis' case, both companies used the merger as a catalyst to fundamentally alter their internal processes, optimizing every aspect from R&D to sales and general strategy (Goedhart et al., 2015).

A less promising example is Valeant Pharmaceuticals, originally a Californian company that was acquired by the Canadian Biovail Corporation in 2010. It developed a strategy that revolved around M&A with minimal R&D spending. Initially appearing successful, Valeant employed excessive pricing tactics to support its leverage, eventually leading to an investigation by the U.S. Senate and Securities and Exchange Commission (SEC). The company collapsed under its debt and was forced to sell off many of its acquisitions (Crow, 2016).

Danzon et al. (2007) note that pharmaceutical M&A often does little to improve R&D efficiency, and that firms with a focus on inorganic growth often perform worse than their organically-centered peers. Kirchhoff & Schiereck (2011) find that acquirors with higher sales generally perform better in M&A. They hint that R&D focused targets are ideal, but do not test this. It must be determined whether pharmaceutical firms place an extra value on targets with a strong R&D focus, and what the role of acquiror R&D and intellectual property is. This will create a bridge between existing literature, shining a light on the role of R&D in determining M&A strategy.

1.4 Social relevance

In terms of social relevance, a more productive pharmaceutical industry is beneficial. In theory, efficiency in drug development allows for lower prices, and a wider range of treatments for diseases. Furthermore, a dynamic and innovative pharmaceutical industry creates an environment in which multiple drugs are developed concurrently, increasing the probability that a solution to issues such as the Covid-19 crisis is found.

A high-profile example is AZD1222, the leading Covid-19 vaccine which is currently in joint development by AstraZeneca and Oxford University (Kemp, 2020). AstraZeneca was formed in 1999 through a merger of Astra AB and Zeneca Group Plc, after which it became a world-leading pharmaceutical company, as well as Britain's most valuable corporation (Ralph, 2020). Much like with the aforementioned Novartis, successful pharmaceutical M&A can therefore play a crucial role in the general advancement of society.

That being said, there is a darker side to pharmaceutical M&A when it comes to social relevance. Cunningham et al. (2018) highlight that M&A can be used to decrease competition, in order to improve shareholder returns at the cost of innovation or by raising prices. In the United States in particular, anti-competitive behavior is seen as a major factor in rising drug prices, pushing the already expensive healthcare system into unaffordability for many Americans (Kuchler, 2019).

2. Theoretical framework

2.1 The functioning of the pharmaceutical industry

Pharmaceutical companies create value by developing drugs that assist in curing or mitigating various ailments. In order to produce these drugs, significant investment into R&D is required. The R&D process consists of two phases (Ornaghi, 2008). The research or discovery phase entails detecting new chemical entities (NCEs) that could function as medicine. When a potential drug is found, a patent is filed and the second phase starts. The development phase focuses on pre-clinical and clinical testing for both safety and efficacy, as well as obtaining market approval from an agency such as the United States Food & Drug Administration (FDA). After this phase, the drug can be produced and distributed.

Danzon et al. (2007) find that only one out of 250 NCEs that enter pre-clinical trials is eventually approved. Furthermore, the timeframe from discovery to approval is approximately 8 years. This means that significant R&D investment is required to compensate for the high failure rate. In turn, drug prices need to reflect not only the cost to develop and produce the respective drug, but also the 249 other NCEs that never come to fruition.

Furthermore, R&D has become more expensive over the years. Robert Ruffolo, president of R&D at Wyeth Pharmaceuticals (now part of Pfizer), lists external factors such as stricter safety and trial regulation (Ruffolo, 2006). For instance, the Japanese Pharmaceuticals and Medical Devices Agency (PDMA) holds the belief that Japanese are genetically different from Americans and Europeans, and so requires clinical trials to be repeated in Japan even if they were already successful elsewhere. However, Ruffolo also notes that M&A disrupts R&D for up to three years due to organizational uncertainty. Furthermore, he mentions that scientists find it difficult to control costs, as they are primarily focused on maximizing innovation, not always considering cost efficiency. Danzon et al. (2007) observe a similar trend, with R&D costs to develop a new drug rising between 1988 and 2001.

With respect to biotechnological (biotech) firms, they are similar to pharmaceutical companies, but are not exclusively limited to drugs when it comes to the products they develop. Items such as laundry detergent, fertilizer and genetically modified organisms (GMOs) also fall under biotech. A major portion of biotech firms however, is focused on developing drugs. They spend more on R&D and have less sales and production capacity (Gibney et al., 2019), but an advantage is that certain biotech patents last twelve years whereas pharmaceutical rights to manufacture and distribute drugs generally last five years (111th U.S. Congress, 2010). Other than that, biotech companies are similar to pharmaceutical firms, in that they develop drugs which provide solutions for various health issues.

Given the increasing costs of the R&D process, it should be considered which facets are at the core of R&D productivity. Cockburn & Henderson (1996) have researched the role of economies of scale, scope and spillovers in R&D productivity. They find that larger pharmaceutical firms are more productive in conducting research than smaller firms, all else being equal. This implies that it may be desirable to concede an efficiency loss caused by a concentration of market power, in order to allow for a more efficient research process. Furthermore, economies of scope are more significant than those of scale. In this context, economies of scale refer to size benefits that arise from, for instance, not requiring two laboratories or human resources departments. Economies of scope reflect the sharing of knowledge between projects. Logically, a company which has already developed a drug to contain the spread of a specific type of cancer can more efficiently develop a drug to remove it entirely.

With regard to manufacturing and sales costs, marginal costs to produce drugs are generally negligible, leading to some criticism towards drug pricing as being excessive. That being said, cost of goods sold are still significant. The pharmaceutical production process is expected to be of an exceptional standard due to the public health risks involved. Production facilities are regularly inspected by the FDA or similar agencies outside of the U.S., and maintaining a global sales network is required to successfully market new drugs, which weighs into unit costs (Joglekar, 2008).

Given the unavailability of patent and drug data on an appropriate scale, it has been decided to use R&D intensity and intangible asset values as proxies for firm innovativeness and intellectual property, respectively. Kirchhoff & Schiereck (2011) consider R&D intensity as a valid measure for innovative propensity in firms. Furthermore, Cunningham et al. (2018) note that patents further away from expiration are more valuable to protect. This makes balance sheet intangibles a particularly useful measure, as R&D expenditures are capitalized under IFRS accounting rules (KPMG, 2020). Therefore, they are amortized accordingly, and the balance sheet value is adjusted for time to expiry. Furthermore, the measure reflects the potential for economies of scope arising from current patents.

2.2 Mergers and acquisitions in general

Since 2000, over 790,000 M&A transactions have been announced worldwide, with a combined value of more than $57 trillion (IMAA, 2020). In 2019 alone, total M&A deal value amounted to $3.9 trillion (Fortune, 2019). To specify the meaning of M&A, a merger refers to an event in which two firms of approximately the same size decide to combine into a new entity, whereas an acquisition occurs when a company buys another firm, with the intent of absorbing it into the currently existing entity (Hayes, 2019). That being said, for the purposes of this research they will be treated as one and the same. The company that is acquiring the other firm, or initiating the merger, is called the acquiror. The firm that is being acquired is referred to as the target.

The essence of M&A revolves around the magic word of synergy (Damodaran, 2005). Synergies refer to the extra value that is created by combining two separate entities into one. They can be categorized as operating and financial synergies. Operating synergies concern operations, and vary from a more efficient R&D process, to combining salesforces and merging support divisions such as accounting and human resources. Financial synergies refer to benefits arising from improved access to capital, or creating a beneficial tax structure. Company value is determined by cashflows and cost of capital, which are in turn impacted by both types of synergies (Goedhart et al, 2015).

Certain risk factors influence M&A value creation. Synergies may not come to fruition as integration can prove difficult or impossible. Furthermore, acquirors often pay premia on top of a target's market value that are too high, giving away most if not all of the value created by a deal to target shareholders (Goedhart et al, 2015). It should be noted that the latter implies that efficiency can still be improved, despite the acquiror not benefitting from it.

2.3 Mergers and acquisitions in the pharmaceutical industry

As Ruffolo mentioned, firms face challenges in the form of rising R&D costs. Furthermore, smaller biotech firms frequently face severe capital constraints (Kirchhoff & Schiereck, 2011). M&A can serve as an instrument to address these challenges, as it is often cited by firms as providing synergy benefits through making R&D more efficient by consolidating development efforts or sharing knowledge (Ornaghi, 2008). This is in line with Cockburn & Henderson's findings regarding economies of scale and scope. Ruffolo and Danzon et al. seem to reject this, noting that M&A disrupts R&D productivity, at least in the short term.

Secondly, it is also possible that firms acquire innovative targets with the goal of eliminating certain development efforts, in order to remove competition to their own products (Cunningham et al., 2018). This way, control of a specific market (e.g. a specific disease) is maintained. Anti-trust legislation generally prevents large, horizontal mergers when they are aimed at market monopolization, but acquisitions of smaller firms are often allowed. A firm with significant intellectual property may therefore seek to protect it by acquiring potential small competitors in so-called killer acquisitions.

Thirdly, sales and manufacturing synergies can form motivations for M&A activity. Firms with an established sales and production force can outsource R&D by acquiring innovative targets, utilizing their supply chain in conjunction with the target firm's drug development pipeline to create value (Higgins & Rodriguez, 2006).

2.4 Efficient market hypothesis

In order to evaluate the process of value creation in pharmaceutical M&A, it would be ideal to consider the material impact of M&A on the innovative capacity of firms, as well as cashflows and cost of capital, to determine the actual value created. Because it is practically impossible to analyze deals in such an in-depth way whilst still maintaining a representative sample, it is elected to use acquiror and target cumulative abnormal returns (CARs) as a proxy for M&A success. CARs refer to the abnormal or excess return of a stock on top of what would normally be expected based on a firm's exposure to the general market, summed over a certain period of time. It can be perceived as what investors estimate to be the value created by the M&A deal upon announcement (Martynova & Renneboog, 2008). Furthermore, positive CARs directly result in the creation of shareholder value, which is the goal of M&A, and the legal purpose of a corporation (Goodpaster, 1991).

The efficient market hypothesis by Eugene Fama (1970) states that financial markets inherently reflect all available information, implying that a company's stock price contains all current information on future cashflows and costs of capital. It exists in three forms. The weak form states that stock prices reflect historical prices. The semi-strong form assumes that prices adjust to obvious public information such as earnings announcements, stock splits and M&A. Lastly, the strong form states that private information, such as specific investor research, is also incorporated in stock prices. It is generally accepted that the semi-strong form holds most of the time, so CARs are a suitable proxy for M&A value creation as they reflect the perceived impact of M&A on company value (Henderson, 1990).

2.5 Hypotheses

First, it is key to determine whether pharmaceutical firms are actively pursuing a strategy that values synergies generated by acquiring R&D intensive firms. To determine this, target CARs will be regressed on target R&D intensity. In an M&A deal, the target is acquired at the market price, plus (or minus) a premium. The premium signals acquirors' expectations about synergies that could arise from an M&A deal. Following the efficient market hypothesis, the target stock will appreciate to the price that is eventually paid by the acquiror, so that the acquisition premium is reflected in target CARs. This yields the following hypothesis:

***H1**: Target R&D intensity positively correlates with the cumulative abnormal return of the target stock.*

Secondly, Kirchhoff & Schiereck (2011) mention that sales synergies play a significant role in pharmaceutical M&A. Smaller, innovative firms lack the manufacturing and sales facilities of larger companies. Therefore, synergies could originate from a positive interaction between target R&D

intensity, which reflects the innovative capacity of the target, and acquiror sales, which reflect the acquiror's manufacturing capacity, as well as its sales network.

***H2**: The positive correlation between target R&D intensity and target cumulative abnormal returns is strengthened by acquiror sales.*

The quintessential reason to undertake M&A activity for acquirors is to create value for their own shareholders. Firstly, Kirchhoff & Schiereck (2011) state that acquirors with low R&D intensity perform better. Secondly, as mentioned earlier, acquirors can outsource R&D by acquiring innovative targets, reducing the need for in-house R&D. Therefore, the following hypothesis is constructed.

***H3**: Acquiror R&D intensity negatively correlates with the cumulative abnormal return of the acquiror stock.*

Then, it must be determined if the observed aspects of targets mentioned by hypotheses one and two generate value for acquiring firms. If those factors result in positive target CARs, this results from higher premia paid by acquirors on the basis of said factors. Whether or not these premia are justified, in turn, depends on the value created for acquiring firms based on target R&D intensity and an interaction between target R&D and acquiror sales. The fourth hypothesis is therefore as follows.

***H4**: The positive correlation between target R&D intensity and acquiror cumulative abnormal returns is strengthened by acquiror sales.*

Finally, Cunningham et al. mention that acquirors undertake acquisitions in order to prevent targets from creating competing drugs (2018). This implies that acquirors with significant intellectual property, reflected by relatively more intangible assets, perform better. An alternative explanation could be that acquirors with numerous patents are more easily able to realize potential economies of scope arising from acquisitions (Cockburn & Henderson, 1996). The last hypothesis is thereby constructed.

***H5**: Acquiror's relative dependence on intellectual property positively correlates with the cumulative abnormal return of the acquiror stock.*

Based on the answers to hypotheses one and two, it can be determined which strategies acquiring firms are pursuing. Hypothesis four serves to confirm the effectiveness of those strategies, whereas hypotheses three and five provide an answer to whether M&A can serve to fill R&D gaps or protect patents. Then, an accurate framework for the role of R&D in pharmaceutical M&A is constructed.

3. Data & methodology

3.1 Data selection

In order to answer the hypotheses, data has been obtained on 304 M&A deals between January 1st, 2000 and May 14th, 2020, from the ThompsonONE SDC database. The sample has been selected based on the following criteria.

- The acquiror & target mid industry based on the Thompson Reuters Business Classification (TRBC) is either *Biotechnology* or *Pharmaceuticals.*
- The acquiror & target nations are OECD members. This includes the following 37 countries: *Australia, Austria, Belgium, Canada, Chile, Colombia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.*
- Acquiror & target firms are *publicly listed*.
- The amount of target shares owned by the acquiror post-transaction is larger than *50%*.
- Deal value must exceed *$10 million*.
- Deal type must be a *disclosed value M&A deal*.
- Deal status must be *completed.*

To complement financial and deal data from ThompsonONE, Datastream has been used to obtain stock returns and CARs around the announcement dates for each of the deals, for both the target and acquiror. Furthermore, acquiror R&D expenses were unavailable on ThompsonONE, and were thus also obtained via Datastream. All target financial data originate from annual financial statements one year prior to the M&A announcement date. Acquiror R&D expenses also reflect that value one year prior to the deal, whereas all other acquiror financial data reflects figures from the last twelve months prior to announcement. Furthermore, ThompsonONE uses IFRS accounting data.

3.2 Cumulative abnormal returns

CARs are used as dependent variables, to evaluate value creation. To obtain them, Datastream is used in conjunction with the event study tool provided by the Erasmus Data Service Center. Datastream codes and event dates are obtained through the ThompsonONE SDC database, which are matched to Datastream using the event study tool. Using the M&A announcement day as t = 0, a control period from t = -106 to t = -6 is used to determine the exposure of company stocks to the MSCI world index. This index is chosen since it reflects stock markets in developed economies, who are generally also

OECD members (MSCI, 2020). Then, abnormal returns are calculated by subtracting expected normal returns from observed returns, as seen in expression 1.

$$1) \quad AR_{i,t} = R_{i,t} - \alpha_i - \beta_i * R_{m,t}$$

Where:

- $AR_{i,t}$ = The abnormal return of a company stock i, when time is t.
- $R_{i,t}$ = The return of a company stock i, when time is t.
- a_i = The component of stock returns that is specific to company i.
- β_i = The exposure of company stock i to the MSCI world index.
- $R_{m,t}$ = The return of the MSCI world index when time is t.

Cumulative abnormal returns can then be computed by summing up abnormal returns over a certain interval. This is done using expression 2:

$$2) \quad CAR_{[-t,t]} = \sum_{-t}^{t} AR_{i,t}$$

Where:

- $CAR_{-t,t}$ = The abnormal return of a company stock i, summed up over the interval [-t, t].

This process is repeated for both acquirors and targets, so that value created by the M&A deal announcement for, respectively, the acquiror and target shareholders can be determined.

Due to uncertainty regarding the announcement date or potential leakage, the abnormal return on t = 0 does not necessarily reflect the full impact of the announcement. It is preferable to obtain a range. Having obtained abnormal returns between t = -5 and t = 5, it should be tested which range is optimal. The following ranges are considered.

Table 1: Target CAR

Interval	Mean CAR (%)	Positive	Negative	χ^2 p-value	z - value	Prob > |z|
T [-5, 5]	42.8%***	251	34	0.0000	12.892	0.0000
T [-5, 0]	30.1%***	242	44	0.0000	12.181	0.0000
T [-1, 1]	41.1%***	255	30	0.0000	13.287	0.0000
T [-1, 0]	28.3%***	230	56	0.0000	11.888	0.0000
T [0]	26.9%***	234	52	0.0000	11.768	0.0000
T [0, 1]	39.6%***	251	34	0.0000	13.083	0.0000
T [0, 5]	39.4%***	240	45	0.0000	12.395	0.0000

*Note: *** Significant at the 1% level.*

As can be seen in table 1, target CARs are significantly positive for all intervals. The χ^2 p-values indicate that for all intervals, the hypothesis that CARs are normally distributed is rejected based on Royston's skewness and kurtosis test (Royston, 2011). Furthermore, based on the Wilcoxon signed-rank and the corresponding z - values, it is determined that all target CARs are significantly different from zero (D'Agostino et al., 1990). To determine an appropriate range, acquiror CARs must then be considered.

Table 2: Acquiror CAR

Interval	Mean CAR (%)	Positive	Negative	χ^2 p-value	z - test	Prob > |z|
T [-5, 5]	-0.8%**	130	163	0.0000	-2.040	0.0413
T [-5, 0]	-0.7%*	145	148	0.0000	-1.743	0.0813
T [-1, 1]	-0.7%	141	152	0.0000	-1.430	0.1527
T [-1, 0]	-1.0%**	146	147	0.0000	-2.354	0.0186
T [0]	-1.3%***	131	162	0.0000	-3.122	0.0018
T [0, 1]	-1.0%*	140	153	0.0000	-1.829	0.0673
T [0, 5]	-1.4%**	130	163	0.0000	-2.548	0.0108

*Note: *** Significant at the 1% level, ** at the 5% level and * at the 10% level.*

Again, using Royston's skewness and kurtosis test, it is observed that none of the acquiror CAR ranges in table 2 are normally distributed. The Wilcoxon signed-rank test is used to establish which CARs are significantly different from zero. From this selection, the most suitable range should be chosen qualitatively, to include anticipation effects and delayed reactions, but exclude irrelevant events. The range T [-5, 5] is chosen, as it is statistically different from zero at the 5% level. Furthermore, it allows taking into account event date uncertainty as well as potential leakage, without being an excessively wide range.

3.3 Descriptive statistics

Having established the methodology for evaluating M&A deals, it becomes interesting to consider certain descriptive statistics regarding the sample. From table 3, it becomes clear that acquirors pay an average premium of 58.1% on top of target market capitalization. This is quite high, since Statista determined that average healthcare M&A premia were 26.3% in 2018 (Statista, 2020). That being said, the healthcare sector also includes hospitals and medical technology. Bujak et al. (2020) found that in 2019, premia paid for publicly traded pharmaceutical and biotech companies reached an average of nearly 100%. Perhaps more interesting is the fact that average premia are far higher than target CARs. This could reflect uncertainty regarding the actual execution of the deal (BCG, 2011).

Table 3: Descriptive statistics					
Variable	**Observations**	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Premium	278	58.1%	109.1%	-78.6%	1549.6%
Deal value	304	4125	11594	10	79377
Sales (T)	304	797	2947	0	22834
Sales (A)	293	11427	16730	0	67218
Total assets (T)	293	1865	8201	0	100724
Total assets (A)	298	23875	39114	0	195899
Market capitalization (T)	294	3121	9617	2	78142
Market capitalization (A)	284	43081	61015	19	253214
R&D/Total assets % (T)	229	33.3%	68.3%	0.0%	753.8%
R&D/Total assets % (A)	269	11.0%	11.8%	0.0%	75.6%
Intangibles (T)	184	1292	7458	0	85601
Intangibles (A)	257	11712	22309	0	110977
EBITDA (T)	285	207	988	-460	7954
EBITDA (A)	298	3719	5935	-280	26744
Domestic M&A	304	57.6%	49.5%	0.0%	100%
Payment in stock	304	34.3%	43.6%	0.0%	100%
M&A experience	304	1	2	0	9

Note: Currency amounts are in millions of U.S. Dollars. 'T' and 'A' refer to the target and acquiror, respectively. Domestic M&A is a binary variable.

Furthermore, as expected based on Kirchhoff & Schiereck (2011), acquirors are generally much larger than target firms. When considering market capitalization, it becomes clear that acquirors are on average approximately fifteen times the size of targets. Furthermore, we observe that target firms spend 33.3% of their assets on R&D annually, compared to only 11.0% for acquirors. This is in line with expectations from Higgins & Rodriguez (2005), who note that acquirors can outsource R&D by acquiring innovative firms. Acquirors also have significantly more sales than targets, and 47 out of 304 targets report no sales whatsoever. This could indicate sales synergies playing a role in M&A.

Of all M&A deals in the sample, 43.4% took place between a target and an acquiror who are located in different countries, which could mean that geographic reach plays a role in determining M&A activity. Overall, 52.6% of acquirors and 67.4% of targets were located in the United States. It therefore plays a disproportionally large role in pharmaceutical M&A, since America only makes up 25% of the total OECD population (OECD, 2013).

On average acquirors used stock to pay for 34.3% of the transaction value. Goedhart et al. (2015) indicate that acquirors experience improved abnormal returns when paying in cash rather than stock. Paying in stock transfers some acquisition risk from acquiror to target shareholders as a result of dilution, whereas a cash payment leaves acquiror shareholders with more exposure to M&A risk, which can be good or bad, depending on the likelihood that a deal succeeds in creating value.

Finally, 160 out of 304 acquirors in the sample only undertook one acquisition. One company, Pfizer Inc., undertook a grand total of nine acquisitions over the course of twenty years, including that of Wyeth Pharmaceuticals for $67 billion. The largest acquisition in the sample is that of Celgene Corp. by Bristol-Myers Squibb Co. for $79 billion, which is incidentally one of the largest pharmaceutical M&A deals in history, resulting in the creation of a world-leading oncology firm (Fontanella-Khan et al., 2019).

3.4 Independent variables

In order to answer the hypotheses, target and acquiror CARs must be regressed on certain independent variables. Given that hypothesis two and four revolve around interaction effects, univariate and multivariate least-squares regressions are used, in order to determine how certain variables impact CARs. Furthermore, this is also required given the fact that a number of control variables are used. The independent variables can be observed in table 4.

Table 4: Independent variables		
Variable	**Calculation**	**Represents**
R&D intensity	$\frac{R\&D\ expenses}{Total\ assets}$	The firm's focus on R&D relative to its assets.
Target R&D intensity interaction with acquiror sales	$\frac{Target\ R\&D\ expenses}{Target\ total\ assets} * Ln\ (Acquiror\ sales)$	The interaction between target's R&D focus and acquiror's sales and manufacturing capacity.
Relative intellectual property	$\frac{Intangible\ assets}{Total\ assets}$	The importance of intellectual property relative to a firm's total assets.

Note: variables where 'target' or 'acquiror' are not specified, are calculated for both. All financial variables are measured up to one year prior to the announcement date.

R&D intensity

In order to measure how R&D intensity impacts CARs, the ratio of a firm's total R&D expenses divided by its total assets is used as a proxy (Table 4). Conventionally, R&D expenses divided by sales is used as a measure. However, 47 out of 304 targets have no sales to speak of, and many more only have negligible quantities. The measure of R&D expenses divided by total assets is used as it would be undesirable to exclude such a significant portion of the sample, especially since targets with non-existent sales might be particularly interesting.

R&D interaction with sales

To determine a potential interaction effect between acquiror sales and target R&D intensity, a variable will be added that multiplies these two figures. When including target R&D intensity and acquiror sales as controls in conjunction with the interaction effect, it becomes clear what the impact is of any synergies arising from combining the two, regardless of their individual impact on CARs.

Relative intellectual property

Finally, the ratio of intangible to total assets is used as a proxy for the relative importance of intellectual property to a firm. One advantage over including actual patents themselves, is that balance sheet intangible assets are adjusted for amortization. As mentioned by Cunningham et al. (2018), firms which own patents with a far-off expiry date have more incentives to protect their market position against potential new entrants. Ceteris paribus, companies with patents that are near expiry record a lower balance sheet value for the respective patents than those with patents which last for a longer timeframe. This measure therefore can function as a proxy for incentives to protect intellectual property, as well as the degree to which economies of scope arising from present knowledge might be relevant. Lastly, using nominal rather than relative intangible assets suffers from a size bias which may obscure the impact of time to expiry of patents, hence the ratio to total assets is preferable.

3.5 Control variables

Table 5: Control variables		
Variable	**Calculation**	**Represents**
Tobin's Q	$\frac{Market\ capitalization}{Total\ assets}$	The market valuation of a company's assets, also known as the market-to-book ratio.
Sales	$Ln\ (Sales)$	The natural logarithm of the revenues a company generates annually, adjusted for rebates and discounts.
Payment in stock	$\%\ of\ a\ transaction\ paid\ in\ stock$	The share of an M&A deal paid for in stock rather than cash.
M&A experience	$Sum\ of\ acquiror\ deals\ before\ an\ observation$	The experience an acquiror has in M&A, based on the sample.
Domestic M&A	$1\ if\ target\ nation = acquiror\ nation$ $0\ if\ target\ nation \neq acquiror\ nation$	Dummy variable that indicates whether the acquiror and target firm are located in the same country.
Year	$1\ if\ year = year\ T$ $0\ if\ year \neq year\ T$	Dummy variable to account for macroeconomic factors.

Note: variables where 'target' or 'acquiror' are not specified, are calculated for both. All financial variables are measured up to one year prior to the announcement date.

Tobin's Q

Fuller et al. (2002) highlight that the market-to-book ratio, also known as Tobin's Q, reflects perceived uncertainty around a company. It can be interpreted as the market's current expectation of potential future value generated by a firm's assets. As it is related to expectations regarding a firm's current operations, it is not directly tied to synergies arising from M&A, but it may impact premia. Therefore, it is preferably included as a control, primarily for target CARs.

Sales

Sales are added as a control variable in order to prevent them from clouding the interaction effect between acquiror sales and target R&D intensity. If it were excluded, the interaction coefficient could

reflect the individual impact of target R&D intensity or acquiror sales on CARs, which is undesirable. The natural logarithm is taken to prevent distortion from outliers and to simplify interpretation.

Payment in stock

Goedhart et al. (2015) mention that stock payments in M&A deals reduce risk and returns for acquirors when it comes to creating value. Fuller et al. (2002) observe a similar effect, hence it becomes desirable to include payment method as a control variable. It influences returns originating from M&A, and might similarly also correlate with an R&D variable given its impact on acquisition risk. Therefore, it is chosen as a control.

M&A experience

A firm's previous experience in M&A influences its likelihood of success in future acquisitions, as Fuller et al. (2002) mention that it has a positive effect. Furthermore, the independent variable representing intellectual property may be biased by goodwill. Therefore, it is wise to include this variable, as it can account for the impact of previous M&A on intangible assets.

Domestic M&A

Domestic M&A is interesting to consider, as cross-border activity may be a means for firms to expand sales or manufacturing capacity to various geographies, or reduce country-specific risk (Hughes et al. 1999). Furthermore, it may impact the likelihood of successful integration between firms, making this binary variable a good control to consider (Kirchhoff & Schiereck, 2011).

Year

The final control used is that of deal year, which is operationalized as a series of dummies from 2000 to 2019, which take a value of one if the deal is in the respective year. There is no dummy for the year 2020, to prevent multicollinearity. Including this variable as a control prevents macroeconomic, time-specific factors from biasing the regressions.

3.6 Research methodology

As mentioned earlier, univariate and multivariate least-squares regressions will be used in order to answer the hypotheses. The following regressions are constructed.

3) $$Target\ CAR = \alpha_i + \beta_1 * Target\ R\&D\ intensity + \beta_j * Control\ variable_j$$

4) $$Target\ CAR = \alpha_i + \beta_1 * Target\ R\&D\ intensity + \beta_2 * (Target\ R\&D\ intensity * Ln(Acquiror\ sales)) + \beta_3 * Ln(Acquiror\ sales) + \beta_j * Control\ variable_j$$

5) $Acquiror\ CAR = \alpha_i + \beta_4 * Acquiror\ R\&D\ intensity + \beta_j * Control\ variable_j$

6) $Acquiror\ CAR = \alpha_i + \beta_1 * Target\ R\&D\ intensity + \beta_2 * \big(Target\ R\&D\ intensity * Ln(Acquiror\ sales)\big) + \beta_3 * Ln(Acquiror\ sales) + \beta_j * Control\ variable_j$

7) $Acquiror\ CAR = \alpha_i + \beta_5 * Acquiror\ relative\ intellectual\ property + \beta_j * Control\ variable_j$

Where:

- $Target\ CAR$ = The cumulative abnormal return of the target firm.
- $Acquiror\ CAR$ = The cumulative abnormal return of the acquiring firm.
- α_i = A constant value specific to regression model i.
- β_1 = A coefficient that captures the correlation between target R&D intensity and CAR.
- β_2 = The coefficient that represents an interaction effect between target R&D intensity and acquiror sales.
- β_3 = The coefficient that represents the correlation of the natural logarithm of acquiror sales with CAR.
- β_4 = A coefficient that reflects the correlation of acquiror R&D intensity with CAR.
- β_5 = The coefficient that demonstrates the correlation of the ratio of acquiror intangible to total assets with CAR.
- β_j = The coefficient which reflects the correlation of control variable j with CAR. It is used for the control variables in table 5.

All regressions are carried out in both univariate and multivariate formats, e.g. the correlation of acquiror R&D intensity with acquiror CAR is tested both with and without controls. Furthermore, for both acquiror and target CARs, one model is constructed that includes all variables.

4. Results & interpretation

4.1 Determinants of target cumulative abnormal returns

As can be observed in table 6, both target R&D intensity and an interaction effect between target R&D intensity and acquiror sales significantly and positively correlate with target CARs. The coefficient of 0.239 for target R&D intensity in model 1 implies that for every extra percentage point in target R&D over assets, target CAR increases by 0.2%. It is significant at the 5% level in a univariate regression, as well as in the multivariate version. This effect becomes clearer in model 3, with an R^2 of 21.4%. In turn, acquiror firms seem to place a value on target R&D intensity, which they are willing to pay for in premia.

Table 6: Regression of target CAR with T[-5, 5] on independent and control variables

Variable	Model 1	Model 2	Model 3	Model 4
Target R&D intensity	0.239** (0.104)	-0.110 (0.135)	0.309** (0.128)	-0.020 (0.183)
Target R&D intensity * Ln (Acquiror sales)		0.145*** (0.032)		0.105*** (0.036)
Ln (Acquiror sales)		-0.001 (0.019)		-0.016 (0.027
Target Tobin's Q			-0.010** (0.005)	-0.005 (0.006)
Payment in stock			-0.003** (0.001)	-0.002 (0.002)
M&A experience			0.021 (0.026)	-0.001 (0.031)
Domestic M&A			0.113 (0.096)	0.058 (0.098)
Year dummies	No	No	Yes	Yes
Constant	0.411*** (0.056)	0.247* (0.142)	0.099 (0.506)	0.254 (0.530)
Observations	220	214	219	213
R^2	2.4%	14.7%	21.4%	25.3%

*Note: *** Significant at the 1% level, ** at the 5% level and * at the 10% level.*

With regards to an interaction effect between target R&D intensity and acquiror sales, in model 2 it appears to be the case that there is a positive interaction effect between these factors, which is significant at the 1% level. In model 2, target R&D intensity becomes insignificant, and negative. In model 4, controls are added and it can be observed that the interaction effect positively correlates with target CARs at 1% significance, whereas the effect of target R&D intensity remains insignificant.

Based on the sample, acquirors are willing to pay significant positive premia for targets with a strong focus on R&D. Furthermore, synergies between target R&D and acquiror sales seem plausible given

the results in model 2 and 4. Finally, it is probable that model 2 and 4 suffer from a multicollinearity problem, as table 7 indicates that target R&D intensity and the interaction between R&D and sales are strongly positively correlated. It is therefore safe to conclude that target R&D intensity is still significantly, positively correlated to target CARs.

Table 7: Target independent variable correlation matrix			
Variable	Target R&D intensity	R&D interaction with sales	Ln (Acquiror sales)
Target R&D intensity	1.000		
Target R&D intensity * Ln (Acquiror sales)	0.821	1.000	
Ln (Acquiror sales)	-0.089	0.184	1.000

4.2 Determinants of acquiror cumulative abnormal returns

Having established that acquiring firms place a value on target R&D intensity and a potential interaction with their own sales, it becomes interesting to consider whether these factors in fact create shareholder value for acquirors. To determine the role of acquiror's own R&D, as well as their intellectual property, the impact of these factors on acquiror CARs should also be considered.

Table 8 indicates that a significant, negative relationship exists between acquiror R&D intensity and acquiror CARs. Based on model 1, each percentage point by which acquiror R&D intensity increases, leads to a 0.2% decrease in acquiror CAR, which is significant at a 1% level. This implies that acquirors with larger R&D investments benefit less from M&A. This is logical when considering that Higgins & Rodriguez (2006) found that pharmaceutical acquirors often suffer from a depleted research pipeline, whereas non-merging firms have sufficient internal innovation to not require an M&A deal.

With respect to intangible assets, a positive relationship exists between the ratio of intangibles to total assets and acquiror CARs, which is significant at the 1% level. This is a particularly interesting connection, and it is in accordance with what Cunningham et al. (2018) mention as potential impetus for M&A. Pharmaceutical firms could be acquiring other companies in order to protect their current market position, which is relatively important to them. It could also signal the existence of economies of scope, which are more readily exploited by firms with more intellectual property.

Finally, the interaction between target R&D intensity and acquiror sales seems to disappear when considering acquiror CARs. The interaction effect has such a large standard deviation relative to its coefficient, that it becomes impossible to interpret. A reason for this could be that value originating from this interaction is already paid to targets through premia. Alternatively, there might be specific factors which impact the likelihood of sales synergies materializing, which are not accounted for in this regression.

Table 8: Regression of acquiror CAR with T[-5, 5] on independent and control variables							
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
Acquiror R&D intensity	-0.163*** (0.062)			-0.134* (0.069)			-0.216 (0.135)
Relative intellectual property		0.077*** (0.030)			0.073** (0.037)		0.024 (0.044)
Target R&D intensity * Ln (Acquiror sales)			-0.002 (0.003)			-0.002 (0.003)	-0.002 (0.003)
Target R&D intensity			0.009 (0.021)			0.010 (0.022)	0.009 (0.031)
Ln (Acquiror sales)			0.004 (0.003)			0.004 (0.004)	-0.001 (0.005)
Payment in stock				0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
M&A experience				0.002 (0.004)	-0.001 (0.004)	-0.003 (0.005)	0.001 (0.005)
Domestic M&A				-0.017 (0.014)	-0.014 (0.015)	-0.015 (0.016)	-0.017 (0.016)
Year dummies	No	No	No	Yes	Yes	Yes	Yes
Constant	0.007 (0.010)	-0.027** (0.012)	-0.030 (0.023)	0.109 (0.085)	0.084 (0.083)	0.074 (0.087)	0.133 (0.087)
Observations	266	253	219	266	253	219	193
R^2	2.5%	2.7%	0.8%	12.4%	12.0%	11.5%	15.3%

*Note: *** Significant at the 1% level, ** at the 5% level and * at the 10% level.*

When considering controls in model 4 and 5, both acquiror R&D intensity and acquiror relative intangibles remain significant and with the same sign. Their significance does however decrease to a 10% and 5% level, respectively. In model 6, it can be seen that even when considering controls, an interaction effect between target R&D intensity and acquiror sales does not present itself.

When adding all variables into model 7, acquiror R&D intensity and relative intellectual property become insignificant, although the signs remain unchanged. This could be because acquiror R&D intensity and relative intellectual property are strongly negatively correlated, as can be seen in table 9. Acquiror sales are also negatively and positively correlated to acquiror R&D intensity and relative intellectual property, respectively. A multicollinearity problem could therefore cause the variables to become insignificant in model 7.

Table 9: Acquiror independent variable correlation matrix

Variable	Acquiror R&D intensity	Relative intellectual property	Target R&D intensity * Ln (Acquiror sales)	Target R&D intensity	Ln (Acquiror sales)
Acquiror R&D intensity	1.000				
Relative intellectual property	-0.494	1.000			
Target R&D intensity * Ln (Acquiror sales)	0.043	0.057	1.000		
Target R&D intensity	0.219	-0.005	0.899	1.000	
Ln (Acquiror sales)	-0.283	0.258	0.156	-0.046	1.000

All in all, the results are interesting. The intangibles ratio is particularly hard to interpret, so it will be given more attention in the final section. With regards to the factors impacting target CARs, as well as the connection between acquiror R&D intensity and acquiror CAR, the results were more or less as expected. More jarringly, however, acquirors seem to pay targets for two items, namely target R&D intensity and an interaction with acquiror sales, despite the fact that these variables are not positively or significantly correlated to acquiror CARs. Lastly, it must be noted that as table 2 shows, using the interval of T[-5, 5] for acquiror CARs illustrates that generally, acquirors destroy 0.8% of their own shareholder value upon announcement. This exemplifies that value creation is not a given in M&A, signifying the relevance of identifying key factors in M&A success to improve corporate strategy. Additionally, given the relatively low R^2 values in models 1 to 3, it becomes clear that certain characteristics do not automatically explain M&A success. Therefore, evaluating deals on a case-by-case basis remains crucial.

5. Conclusion

5.1 Answering the hypotheses

Having obtained and discussed results obtained from the sample of 304 M&A deals between January 1st, 2000 and May 14th, 2020, it should be considered whether the hypotheses are accepted or rejected, based on the data and regression results.

***H1**: Target R&D intensity positively correlates with the cumulative abnormal return of the target stock.*

Based on the results in section 4.1, it has been determined that target R&D intensity is significantly and positively correlated to target CARs (table 6). Hypothesis one is therefore accepted.

***H2**: The positive correlation between target R&D intensity and target cumulative abnormal returns is strengthened by acquiror sales.*

Furthermore, table 6 also indicates that an interaction effect between target R&D intensity and acquiror sales exists, independently from the individual relationships between these variables and target CAR. Given that the interaction effect is significant and positive, hypothesis two is also accepted.

***H3**: Acquiror R&D intensity negatively correlates with the cumulative abnormal return of the acquiror stock.*

With regards to hypotheses three, it is accepted based on table 8 in section 4.2. There exists a statistically significant, negative relationship between acquiror R&D intensity and acquiror CARs, both with and without control variables. In model 7, the effect is insignificant due to multicollinearity.

***H4**: The positive correlation between target R&D intensity and acquiror cumulative abnormal returns is strengthened by acquiror sales.*

Interestingly, hypothesis four has to be rejected based on the findings in the sample (table 8). There seems to be no statistically significant evidence for an interaction effect between target R&D intensity and acquiror sales which correlates with acquiror CAR.

***H5**: Acquiror's relative dependence on intellectual property positively correlates with the cumulative abnormal return of the acquiror stock.*

The last hypothesis presents the idea that the ratio of intangible to total assets for acquirors, which serves as a proxy for the importance of intellectual property, positively impacts the cumulative abnormal return of the acquiror stock. Based on table 8, the hypothesis is accepted, as a statistically significant, positive relationship exists between the intangibles ratio and acquiror CARs in model 2 and 5. It can be safely stated that the effect becomes insignificant in model 7 due to multicollinearity. Therefore, the following overview of hypotheses is created.

Table 10: An overview of hypotheses

Hypothesis	Statement	Result
1	Target R&D intensity positively correlates with target CAR.	Accepted
2	The correlation between target R&D intensity and target CAR is strengthened by acquiror sales.	Accepted
3	Acquiror R&D intensity negatively correlates with acquiror CAR.	Accepted
4	The correlation between target R&D intensity and acquiror CAR is strengthened by acquiror sales.	Rejected
5	Acquiror relative intellectual property positively correlates with acquiror CAR.	Accepted

5.2 Implications for the research question

Coming back to the role that research & development plays in pharmaceutical mergers & acquisitions, a number of interesting observations are made. Firstly, as expected based on Higgins & Rodriguez (2006), acquirors with lower R&D intensity ratios seem keen to outsource it, by buying targets with higher relative R&D investments. Furthermore, the interaction effect between target R&D intensity and acquiror sales seems to be a reason for acquirors to pay higher premia, but it remains impossible to pinpoint how potential synergies arising from this interaction create value for acquiror shareholders.

As Danzon et al. (2007) and Ruffolo (2006) note, it may indeed be the case that M&A is disruptive in R&D processes, and synergies may not materialize at all times, making M&A unappealing to acquirors with sufficient internal R&D. Furthermore, Goedhart et al. (2015) note that acquirors have an unfortunate tendency to give away synergy value to target shareholders in the form of premia, which could help in explaining the findings from this sample.

With respect to the role of intellectual property in pharmaceutical M&A, i.e. the fruits of previous R&D investments, the data shows particularly interesting results. Acquirors with more intangible assets

relative to their total assets appear to be significantly more successful in M&A. There could be multiple explanations.

First of all, Cockburn & Henderson (1996) assert that larger pharmaceutical firms experience more internal knowledge spillovers, and economies of scope. Logically, firms with more intellectual property would then be more likely to create value from acquiring companies which pursue similar R&D. This ties in with Higgins & Rodriguez (2006) in supporting the idea that outsourcing R&D can create efficiency by combining the development efforts and knowledge of the acquiror and target. Thereby, costs to find and develop NCEs into new drugs will decrease.

Another explanation could be that, like Cunningham et al. (2018) note, pharmaceutical companies use M&A to buy out potential competitors to protect their current patents against newer, more innovative drugs that could replace their own products. The further away a patent is from expiring, the more valuable it is to protect. Given that intangible assets are amortized based on the time to expiry, this would be logical as patents with a later expiry date are recorded at higher values. However, Cunningham et al. highlight that this behavior was only found in 6% of their sample, making this conclusion less probable.

That being said, other items, in particular goodwill, could also impact this finding. When a premium is paid for a target company, this difference between the transaction price and market value goes onto the acquiror balance sheet as goodwill. Successful acquirors, who may be willing to pay higher premia, therefore have higher intangible to total assets ratios, which in turn could indicate an improved probability of future M&A success. However, since acquiror M&A experience was found to be insignificant in explaining acquiror returns, goodwill is unlikely to impact acquiror returns.

Essentially, from the perspective of the acquiror, M&A incentives are the greatest when in-house R&D intensity is low and patents are important. Care is warranted however, since not all M&A deals create value, and deal success will depend on the compatibility of the target and acquiror, as well as the premium paid. A thoughtful acquiror may enhance its efficiency through economies of scope found in M&A and create value, if they prevent transferring too much of it to target shareholders in negotiations.

5.3 Suggestions for future research

It would be interesting to consider the exact determinants behind the connection between the intangibles ratio and acquiror CARs, and whether there is a trade-off between economies of scope on the one hand, and anti-trust concerns on the other. Furthermore, given the examples of Novartis and AstraZeneca mentioned earlier, it is clear that M&A has the potential to foster innovation in companies.

This study has not considered specific overlaps between R&D departments or corporate culture, for instance, so it is possible that whilst the sample on aggregate does not yield synergies arising from target R&D intensity, these may exist in certain instances. Furthermore, target intellectual property could be considered in detail to provide a more complete framework.

In terms of the social impact of pharmaceutical M&A, it can play a crucial role in contributing to more efficient drug development when economies of scope arise (Cockburn & Henderson, 1996). In that regard, this thesis has positive findings. However, with regards to the cost of healthcare, anti-competitive behavior can be problematic, given the weak position of insurance companies in the United States (Time, 2019).

In the Netherlands, the government negotiates drug prices directly with pharmaceutical companies, pushing down prices due to the relatively large bargaining power of the government (Rijksoverheid, 2020). Contrastingly, in the United States there are countless small, private insurers who negotiate prices with pharmaceutical firms. Given the absence of strict price regulation, this results in an incredibly expensive healthcare system. In 2018, 27.5 million Americans had no health insurance to speak of, with many more being underinsured (U.S. Census Bureau, 2019) . As a result, Donald Trump has repeatedly pressed pharmaceutical companies to lower drug prices, even taking measures to import drugs from Canada to evade the American prices (FDA, 2019). Therefore, despite the fact that anti-competitive M&A may not be that prevalent, it must still be considered as an undesirable risk.

On the flipside, it has been noted that the United States contributes far more than any other country to pharmaceutical research & development, as between 1992 and 2004 43.7% of drugs developed globally originated from America (Anderson et al., 2010). Therefore, it would be preferable to find an approach to the pharmaceutical industry which stimulates innovation through M&A, whilst at the same time addressing the problem of anti-competitive behavior in companies.

5.4 Closing statements

Concludingly, based on financial data, evidence has been found that intangible assets such as patents can play a significant role in pharmaceutical M&A. Furthermore, R&D remains an important driver within the industry, on both a general level and in M&A. For firms lacking internal R&D but with sufficient in-house knowledge, M&A can create value by leading them towards a more innovative and efficient future. However, firms must be wary of potential negative impacts of M&A on R&D, and determine strategy on a case-by-case basis. Regulators can then create corresponding frameworks to ensure that this results in value creation for society at large.

6. Appendix

6.1 Bibliography

111th U.S. Congress (2010). *Patient Protection and Affordable Care Act*. United States House of Representatives. Retrieved from: https://www.congress.gov/bill/111th-congress/house-bill/3590/text

Anderson, G., Carpenter, D., Hebert, P., Keyhani, S. & Wang, S. (2010). *US Pharmaceutical Innovation in an International Context.* National Center for Biotechnology Information. Retrieved from: https://www-ncbi-nlm-nih-gov.eur.idm.oclc.org/pmc/articles/PMC2866602/

Bansal, R., De Backer, R. & Ranade, V. (2020). *What's behind the pharmaceutical sector's M&A push*. McKinsey & Company. Retrieved from: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/whats-behind-the-pharmaceutical-sectors-m-and-a-push

Bogle, K. (2020). *IFRS vs. US GAAP: R&D costs.* KPMG. Retrieved from: https://advisory.kpmg.us/articles/2017/ifrs-vs-us-gaap-rd-costs.html#:~:text=Under%20US%20GAAP%2C%20R%26D%20costs,1%20are%20expensed%20as%20incurred.&text=Under%20IFRS%20(IAS%20382,when%20certain%20criteria%20are%20met.

Bujak, E., Geilinger, U. & Leo, C. (2020). *HBM Pharma/Biotech M&A Report 2020.* Retrieved from: https://hbmpartners.com/media/docs/industry-reports/HBM-Pharma-Biotech-M-A-Report-2020.pdf

Cockburn, I. & Henderson, R. (1996). *Scale, Scope and Spillovers: The Determinants of Research Productivity in Drug Discovery.* The Rand Journal of Economics, Vol. 27, No.1, pp. 32-59.

Cherowbrier, J. (2020). *M&A: average premiums Worldwide 2017-2018, by industry.* Statista. Retrieved from: https://www.statista.com/statistics/978475/average-premiums-worldwide-by-industry/

Croft, A. (2019). *The Year in M&A: 'Super Mega' Deals and a Fourth-Quarter Surge Put Dealmakers on Top in 2019*. Fortune Magazine. Retrieved from: https://fortune.com/2019/12/31/super-mega-mergers-deals-2019/

Crow, D. (2016). *Valeant: The harder they fall*. Financial Times. Retrieved from: https://www.ft.com/content/dbc52fa8-f0d6-11e5-9f20-c3a047354386.

Cunningham, C., Ederer, F. & Ma, S. (2018). *Killer Acquisitions.* Available at SSRN: https://ssrn.com/abstract=3241707

D'Agostino, R., Belanger, A. & D'Agostino, R. (1990). *A suggestion for using powerful and informative tests of normality*. American Statistician 44: 316–321.

Damodaran, A. (2005). *The Value of Synergy.* Stern School of Business. Retrieved from: http://people.stern.nyu.edu/adamodar/pdfiles/papers/synergy.pdf

Danzon, P., Epstein, A. & Nicholson, S. (2007) *Mergers and Acquisitions in the Pharmaceutical and Biotech Industries*. Managerial and Decision Economics, 28: 307-328.

Entis, L. (2019). *Why Does Medicine Cost So Much? Here's How Drug Prices Are Set.* Retrieved from: https://time.com/5564547/drug-prices-medicine/

Fontanella-Khan, J., Neville, S. & Platt, E. (2019). *Bristol-Myers Squibb to acquire Celgene in $90bn deal.* Financial Times. Retrieved from: https://www-ft-com.eur.idm.oclc.org/content/560429c4-0f4f-11e9-a3aa-118c761d2745

Fuller, K., Netter, J. & Stegemoller, M. (2002). *What Do Returns to Acquiring Firms Tell us? Evidence from Firms That Make Many Acquisitions.* The Journal of Finance, Vol. 57, No. 4, pp. 1763-1793.

Gibney, M., Shoaib, Z., Woleben, J. (2019). *Big Pharma spends up to 31% of expenses on R&D to justify price of medicines.* S&P Global Market Intelligence. Retrieved from: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/50306210

Goedhart, M., Koller, T. & Wessels, D. (2015). *Measuring and Managing the Value of Companies.* McKinsey & Company.

Goodpaster, K. (1991). *Business Ethics and Stakeholder Analysis.* Business Ethics Quarterly, 1(1), 53-73.

Hayes, A. (2019). *Mergers and Acquisitions – M&A.* Investopedia. Retrieved from: https://www.investopedia.com/terms/m/mergersandacquisitions.asp

Henderson, G. (1990). *Problems and Solutions in Conducting Event Studies*. Journal of Risk and Insurance, Vol. 57, No. 2, pp. 282-306.

Higgins, M. & Rodriguez, D. (2006). *The outsourcing of R&D through acquisitions in the pharmaceutical industry.* Journal of Financial Economics. 80, 351-283.

Hughes, J., Lang, W., Mester, L. & Moon, C. (1999). *The Dollars and Sense of Bank Consolidation.* Journal of Banking & Finance, Vol. 23, pp. 291-324.

IMAA (2020). *M&A Statistics.* Institute of Mergers, Acquisitions and Alliances. Retrieved from: https://imaa-institute.org/mergers-and-acquisitions-statistics/

Joglekar, G. (2008). *Analysis of Manufacturing Costs in Pharmaceutical Companies*. Journal of Pharmaceutical Innovation, 3:30-40.

Kemp, A. (2020), *AstraZeneca advances response to global COVID-19 challenge as it receives first commitments for Oxford's potential new vaccine.* AstraZeneca. Retrieved from: https://www.astrazeneca.com/media-centre/press-releases/2020/astrazeneca-advances-response-to-global-covid-19-challenge-as-it-receives-first-commitments-for-oxfords-potential-new-vaccine.html

Kirchhoff, M. & Schiereck, D. (2011). *Determinants of M&A Success in the Pharmaceutical and Biotechnological Industry.* The IUP Journal of Business Strategy, Vol. VIII, No. 1.

Kronimus, A., Nowotnik, P., Roos, A. & Stange, S. (2011). *M&A: Using Uncertainty to Your Advantage.* The Boston Consulting Group. Retrieved from: https://www.bcg.com/documents/file92924.pdf

Kuchler, H. (2019). *Why prescription drugs cost so much more in America.* Financial Times. Retrieved from: https://www.ft.com/content/e92dbf94-d9a2-11e9-8f9b-77216ebe1f17.

Mikulic, M. (2020). *Revenue of the worldwide pharmaceutical market from 2001 to 2019.* Statista. Retrieved from: https://www.statista.com/statistics/263102/pharmaceutical-market-worldwide-revenue-since-2001/

Morgan Stanley Capital International Inc. (2020). *MSCI Developed Markets Indexes.* Retrieved from: https://www.msci.com/developed-markets

OECD Factbook (2013). *Population and Migration*. Retrieved from: http://www.oecd.org/sdd/01_Population_and_migration.pdf

Ornaghi, C. (2008). *Mergers and innovation in Big Pharma.* International Journal of Industrial Organization 27, 70-79.

Ralph, A. (2020). *AstraZeneca investment in Moderna hits $2bn as vaccine hopes soar*. The Times. Retrieved from: https://www.thetimes.co.uk/article/astrazeneca-investment-in-moderna-hits-2bn as-vaccine-hopes-soar-pjt3x3lpl#:~:text=Astrazeneca%20investment%20in%20Moderna%20hits%20%242bn%20as%20vaccine%20hopes%20soar,-Alex%20Ralph&text=Britain's%20most%20valuable%20public%20company,hopes%20for%20its%20coronavirus%20vaccine.

Rijksoverheid (2020). *Wet geneesmiddelenprijzen*. Art. 1 lid 1 sub c. Retrieved from: https://wetten.overheid.nl/BWBR0007867/2020-03-19

Royston, P. (1991). *sg3.5: Comment on sg3.4 and an improved D'Agostino test.* Stata Technical Bulletin 3: 23–24.

Ruffolo, R. (2006). *Why has R&D productivity declined in the pharmaceutical industry?*. Expert Opinion on Drug Discovery 1:99-102.

United States Food & Drug Administration (2019). *Trump Administration takes historic steps to lower U.S. prescription drug prices.* Retrieved from: https://www.fda.gov/news-events/press-announcements/trump-administration-takes-historic-steps-lower-us-prescription-drug-prices