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Exploring the relationship between innovation and M&A activity in the pharmaceutical industry

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ABSTRACT

The primary objective of this study is to investigate whether there is a correlation between the degree of innovation exhibited by a firm and its propensity to engage in merger and acquisition activities (M&A). Prior research suggested the two activities might be substitutes, whereby a company decides to grow either organically through innovation or rather by acquiring other companies. The empirical analysis is based on an extensive dataset that includes information from more than 60,000 pharmaceutical companies. The data spans a six-year timeframe, from 2015 to 2020. The study utilizes a panel-data regression econometric approach and reveals compelling evidence supporting a positive correlation between a firm's level of innovation and its inclination to engage in mergers and acquisitions. This correlation is robust and shows up consistently within corporations across multiple years, as well as across corporations. Additional results suggest that reverse causality should not be considered as a major concern. These findings provide significant perspectives on the strategic decision-making process of innovative enterprises, elucidating the correlation between innovation, mergers and acquisitions, and the overall performance of the firm in the constantly evolving pharmaceutical industry.

1 INTRODUCTION

The pharmaceutical sector has experienced a notable increase in mergers and acquisitions (M&As) among its key players in recent times. The strategic significance of M&As as a tool for achieving business objectives and navigating the intricate landscape of the pharmaceutical industry is being increasingly acknowledged by pharmaceutical companies. Consequently, the pharmaceutical industry is currently experiencing substantial changes that are altering the competitive landscape and future outlook of companies operating within the sector. The recent trend of M&As can be attributed to various factors such as the desire for portfolio diversification, expansion into untapped markets, cost synergies, and improved innovation capabilities.

In an effort to comprehend the impact that innovation also plays in a firm's environment, prior research has shown that it is essential for fostering economic development in highly competitive contexts (Geroski & Machin, 1992). Concurrently, M&As have surfaced as strategic instruments for attaining success in diverse sectors. According to the traditional paradigm, there exists an alternative interaction between research and development (R&D) and M&As.

The objective of this thesis is to undertake a critical evaluation of the reliability of the aforementioned theory in the pharmaceutical industry. The aim is to provide insights into the interplay between these two strategies and their combined influence on the efficacy and competitiveness of pharmaceutical firms.

1.1 RESEARCH QUESTION

The primary objective of this study is to examine the potential correlation between an organization's level of innovation and its likelihood to participate as a bidder in acquisition activities. This study expands its analysis beyond the internal dynamics of the firm by examining the wider industry context and competitive landscape. It acknowledges the potential impact of these external factors on the likelihood of engaging in acquisitions. This study aims to investigate the complex relationship between innovation, industry dynamics, and competitive environments through a broad approach. The objective is to gain a more detailed comprehension of the factors that motivate firms to engage in acquisition activities. The present investigation's results will enhance the current pool of information regarding strategic decision-making within the framework of mergers and acquisitions.

1.2 THESIS STRUCTURE

The present master thesis consists of five comprehensive chapters, each one serving a distinct purpose in enhancing our comprehension of the correlation between innovation, mergers, and acquisitions (M&As), and the pharmaceutical industry.

The first chapter establishes the groundwork for the investigation by diving into the fundamental themes and performing a comprehensive examination of the current body of literature. The objective of this chapter is to identify any gaps or unaddressed aspects within the existing body of knowledge. This will help to establish the rationale and objectives for the research.

Chapter two focuses on the methodological aspects of the study, providing a detailed account of the research design and data collection methods employed. Special emphasis is placed on defining the variables used in the analysis, ensuring clarity and consistency in measurement.

The third chapter unveils the findings of the empirical analysis that was carried out. Through rigorous data analysis techniques, key findings and insights are extracted, shedding light on the relationship between innovation, M&As, and their impact on the pharmaceutical industry. This chapter additionally scrutinizes the economic significance of the discoveries, underscoring the pragmatic ramifications and plausible advantages for the stakeholders of the industry.

Chapter four delves into the interpretation of the results, providing a comprehensive discussion and analysis of the findings. This chapter also highlights areas that need more study in order to increase the understanding of the intricate processes at work, pointing forth potential directions for future investigation.

Finally, the fifth chapter serves as a concluding chapter by summarizing the major findings and formulating general conclusions in light of the analysis carried out throughout the study. This chapter encapsulates the main contributions of the research, discussing their implications. It serves as a comprehensive summary that offers closure to the study, while also laying the groundwork for future research directions in the field.

Collectively, these five distinct chapters investigate the relationship between innovation, mergers and acquisitions, and the pharmaceutical industry, and form a cohesive framework. This master's thesis endeavors to enhance the existing body of knowledge in this domain by scrutinizing extant literature, performing empirical analysis, and interpreting the findings to provide valuable insights.

2 LITERATURE REVIEW

This chapter aims to provide a comprehensive overview of the most important and influential studies that have been conducted on the topic of innovation, innovation stock, and M&As. To achieve this goal, the chapter will summarize these studies' key findings, methodologies, and conclusions. By doing so, the existing literature on this topic will be established, allowing for the identification of gaps that remain unaddressed.

The analysis will be approached from the general to the specific, the starting point is the definition of the terms of the research question, as to provide a clear preliminary understanding of the themes that are going to be deeply analyzed and debated in the following chapters. Starting from the definition of both innovation and M&As and the main characteristics of those topics and only in the third part analyzing the already existing literature on the possible correlation between the two.

In order to comprehensively evaluate the key characteristics of the topics under consideration, the forthcoming chapter will adopt a multidimensional approach that draws on a combination of academic literature and empirical historical data.

2.1 INNOVATION: AN OVERVIEW

The definition of innovation is quite broad, by looking at some English dictionaries, innovation is defined as a new idea, method, or device that can make a company valuable.

Innovation is undoubtedly important for firms' growth; indeed, it is both a process and a strategy, wherein a truly innovative organization has cultivated a mindset that pervades each aspect of its business operations. As a pervasive attitude, innovation embodies an emotional state and a committed dedication to novelty, capturing a set of values that reflects a conviction to look beyond the present and transform aspirations into tangible realities (Kuczmarski, 2003).

Since innovation remains one of the most elusive dimensions of organizational routines and performance to quantitatively comprehend, Carayannis & Provance (2008) have defined a new framework to measure innovation within a firm. The '3P framework' states that innovation materializes from three critical firm-level factors: Posture, Propensity, and Performance.

- 'Posture' refers to an organization's position within the larger innovation system of its environment, for example, the world area, the industry, and its technological domain.

Identifying the conditions that influence a specific firm within a specific technology regime serving a specific market.

- 'Propensity' is referred to as a firm's ability to capitalize on its posture based on cultural acceptance of innovation. A company may have sufficient resources and a high level of externalized innovation, but its innovation potential may be undeveloped due to cultural or other limitations.
- 'Performance' is the lasting result of innovation, compromising three levels: output, outcome, and impact.

Thus by looking at the performance side of the framework the most accurate way to quantify the economic importance of the innovation process is through direct measurement of innovation output. In essence, it shows if a concept for a novel or enhanced product (expressed, for instance, by a patented innovation) begins to have true economic worth. A patent, instead, documents an invention that makes use of a specific body of knowledge; in this sense, patents are frequently used in research focusing on the output side of the innovation process.

2.2 M&AS: WHAT ARE THEY ABOUT?

The traditional definition of M&As is the act of one firm buying another's whole business or a specific asset. In a broader sense, this suggests that a brand-new combination of preexisting assets is created. According to neoclassical economic theory, synergy advantages will be seen since the new combination will be more productive than the sum of its parts. For the seller to accept the agreement, it must also be in a better financial position than it was before the sale, meaning that the seller's new combination of assets is worth more than its previous combination.

Furthermore, M&As involve several different types of alliances between companies, all of which are used to create new asset combinations. Joint ventures, for example, combine various assets from two or more separate firms into a completely new organization. Just as in an acquisition, this new combination of assets is thought to have greater value than the sum of its parts.

A better definition of M&As would therefore include transactions like mergers, acquisitions, takeovers, tender offers, alliances, joint ventures, minority equity investments, licensing, divestitures, spin-offs, split-ups, carve-outs, leveraged buyouts, reorganizations, restructuring, and contracting related to financial distress and other changes. The most extreme methods that

businesses recombine assets to generate value are acquisitions of entire companies or divisions, however, these are not the only ones. The other types of M&As are far more common than mergers since they are less severe. Additionally, businesses engage in numerous M&A activities over the course of years, with numerous transactions taking place simultaneously.

For the purpose of understanding the rationale behind entering an M&A process by a firm have been developed three competing theories (Ahern & Weston, 2007).

- *Neoclassical theory.* The business rationale for mergers is that they can be positive net present value investments. When the merged firm's worth exceeds the total of the individual firms' pre-merger valuations, a merger adds value. One benefit of merging businesses is that capabilities may be introduced more quickly than through internal initiatives. The urge to respond and alter quickly is intensified by the rising economic instability. A company may adapt to change more quickly through mergers than through internal organic development. Consequently, environments that change more quickly offer M&As a greater potential role.
- *Redistribution theory.* Categorized by which stakeholder group suffers from a merger, there are five redistribution theories: bondholders, labor, pension funds, government (tax savings for the bidder), and consumers (due to enhanced market power).
- *Behavioral theory.* The four main issues deviating from the neoclassical theory of mergers are hubris, market misevaluations, agency problems, and integration problems.

2.3 EXISTING LITERATURE

After having established the reasons why companies engage in M&A processes, the attention can now be redirected toward examining the correlation that occurs between innovation and M&A undertakings. This will involve an analysis of the theoretical underpinnings of the classical theory, its conceptual framework, and the assumptions on which it is based. This will involve a comprehensive review of the relevant literature.

The ensuing literature review will be bifurcated into two macro areas: (1) research that endeavors to investigate the correlation between M&A undertakings and the level of R&D, and (2) studies that assess the effects of M&A transactions for the subsequent advancement of in-house R&D.

As for the first domain, Phillips and Zhdanov (2012) tried to unravel why smaller firms tend to prioritize innovation while larger firms are more inclined towards acquisitions rather than engaging in an "R&D race". Their model demonstrated that an active acquisition market positively affects small and large firms' incentives to innovate and conduct R&D. Specifically, through their work they showed that a firm's incentives to invest in R&D are positively related to the possibility that they are taken over and inversely related to the size of the company itself, thus explaining why larger firms handle less R&D per unit of firm size.

Bena & Li (2013) instead focused their attention on the different roles of established companies with large patent portfolios and low R&D expenses, and companies with high R&D expenses and slow growth in patent output. The study found that companies with large patent portfolios and low R&D expenses were more likely to be acquirers, while companies with high R&D expenses and slow growth in patent output were more likely to be acquired. Furthermore, the technological overlap between firms' innovation activities has a positive and significant effect on the likelihood of a merger pair formation. Moreover, the study uncovered that the degree of technological overlap between firms' innovation activities had a positive and significant impact on the likelihood of a merger pair formation. However, the positive effect of technological overlap on the likelihood of a merger pair formation was reduced for firms that also overlapped in product markets. Finally, the study revealed a positive treatment effect of a merger on post-merger innovation output when there was a pre-merger technological overlap between the merging firms. This led the authors to conclude that the synergies resulting from combining innovation capabilities are a significant driver for corporate acquisitions.

The likelihood of identifying such synergies is higher when the firms involved are related to each other in terms of their operations, markets, or technologies. This is due to the potential for greater compatibility between their respective resources, knowledge bases, and organizational structures.

Cassiman et al. (2005) exhibited an interest in the study of this specific subject matter and so they exploited the role of the ex-ante-relatedness between merger partners and the technological- and market-relatedness of target and acquirer firms, showing that have important separately identifiable consequences for the impact of an M&A on the new entity's R&D and innovation process. The efficiency of R&D activities following a merger depends on whether the merged entities are technologically complementary or substitutive. Merged entities that are technologically

complementary tend to have an increase in R&D efficiency, whereas those that are substitutive tend to have a decrease in R&D inputs after the merger. Additionally, if the merged entities were rivals in the product market before the merger, the reduction of R&D activities tends to be more significant than if they were non-rivals, indicating that the technology gains from mergers may be limited for rival firms.

Talking about market-relatedness it is important to take into consideration also the study provided by Blonigen & Taylor (2000), in which they investigated the existence of a relationship between R&D intensity and patterns of acquisition, discovering a substantial inverse relationship between the two among electronic and electrical equipment firms. Their results highlight how the technological intensity of the industry can lead to a higher level of acquisition. As a matter of fact, the distinctive features of high-tech industries set them apart from other sectors, resulting from not only the condensed lifespan of their products but also the potential for new product introductions to upset the competitive dynamics and prevailing advantages of companies operating within the industry (Chaudhuri and Tabrizi, 1999). In this sense, Ahuja & Katila (2001), contribute with their discovery, affirming that within technological acquisitions (acquisitions that add a knowledge base to the acquirer) the level of acquired knowledge can introduce a positive shock to future innovation output.

Shifting the attention to the second area of this literature review, three different studies have been taken into consideration.

Michael Hitt and Florian Szücs attempted to illustrate the impact of M&A activity on a company's R&D productivity in their studies.

Szücs (2014) evaluated the impact of M&A activity on the growth of R&D spending as well as the R&D intensity of the firms involved. Regarding the mechanics of mergers, it is indicated by the findings that firms with high levels of innovation are selected as targets for mergers. This implies that acquiring firms selectively choose companies with appealing technological portfolios that have not been fully utilized for commercial purposes. As for the acquiring firms, they are predominantly characterized as being both large and profitable. According to the findings, mergers lead to a considerable reduction in the R&D efforts of target companies as they adjust to the new post-merger environment. Similarly, the R&D intensity of acquirers declines significantly due to a sharp increase in sales volume.

Hitt et al. (1991) tried to understand why acquisitions do not always lead to positive firm performance, addressing the issue of diminishing levels of R&D intensity and patent intensity. The findings indicate that modes of entry – acquisitions - may exert a more pronounced influence on R&D investments compared to diversification. Managers may leverage acquisitions as a replacement for innovation, thereby obtaining new technology or products that are novel to their organizations but not necessarily to the market (Clarke et al., 1989). Nevertheless, the decrease in the proportionate R&D expenditures and consequent outputs subsequent to acquisitions implies that the innovativeness of the acquired firms might diminish over time.

Companies engaging in active acquisition or divestiture activities are prone to generate lower levels of internal innovation and place greater dependence on external innovation according to the findings of the research carried out by Hitt et al. (1996). The impact can be attributed to the expenses incurred during the acquisition process and the activities associated with it, which require significant attention and energy from managers. Consequently, due to these transaction costs, managers are left with limited time to focus on other crucial projects, leading to a significant increase in risk aversion, particularly among managers of target firms. As a result, the management of acquiring and target firms may defer major decisions concerning long-term investments, such as research and development, thereby decreasing the innovative potential of their organizations. With respect to the strategy of the firms, their work strongly suggests that the least innovative firms are likely those following a portfolio strategy. Frequently engaging in business acquisitions and divestitures amplify the impact on control systems, both internal and external innovation. Due to the constantly changing business portfolio, these firms rely heavily on financial controls and utilize minimal strategic controls. Despite acquiring innovative businesses, they are less likely to reap the benefits of innovation due to their emphasis on financial controls and the high transaction costs and managerial resources involved in acquisitions and divestitures. As a result, the portfolio strategy may only yield success in industries where innovation is of minor importance, such as mature industries where enhancing internal efficiencies can generate higher returns.

To enhance clarity prior to delving into the uncharted domain of the topic, **Table 1** encapsulates all the aforementioned findings.

Table 2.1 Summary of existing literature.

Author and year	Methods and characteristics	Major findings
Ahuja & Katila (2001)	The paper analyzes the acquisition behavior of global chemicals firms over twelve years and investigates the impact of acquisitions on innovation performance in the following four years.	Within technological the level of acquired knowledge can introduce a positive shock to future innovation output.
Bena & Li (2013)	Unique dataset of US companies over a 23-years period who have entered in a deal of a value higher than 1 million $.	Firms with high portfolio value and low R&D expenses tend to be acquirers, while targets are usual to have an opposite configuration of resources.
Blonigen & Taylor (2000)	Dataset made of 217 US electronic and electrical equipment firms from 1985 to 1993.	In high-technology industries, the probability of firms entering into an M&A process is higher than in industries in which the technology is less important.
Cassiman et al. (2005)	Deep analysis of 31 individual M&A deals.	Valuation of the effects of market- and technological-relatedness in the output of an M&A process.
Hitt et al. (1991)	The firms studied represent 29 industries, for a total of 191 acquisitions completed from 1970 through 1986	Understand why acquisitions do not always lead to positive firm performance, addressing the issue to the diminishing levels of R&D intensity and patent intensity.

Hitt et al. (1996)	A sample of 250 US industrial manufacturing firms, between 1985 and 1991, with at least $25 million in assets for each year of the study.	Companies into M&As usually generate lower levels of internal innovation and place greater dependence on external innovation.
Phillips & Zhdanov (2012)	A sample of firms with matched industry demand data, lagged and contemporaneous non-zero assets including 11,288 firms with 84,471 firm-year observations during the period 1984-2006.	Firms with large portfolio values avoid an R&D race with smaller companies but prefer to buy the second after its R&D process.
Szücs (2014)	265 acquiring firms and 133 merger targets have been considered, both European and from the USA. The study analyses 20 years (from 1999 to 2009).	Mergers lead to a reduction in the R&D efforts of target companies, and the R&D intensity of acquirers' declines.

2.4 UNADDRESSED TOPICS

It is crucial to transfer our attention to identifying the areas that have not yet been effectively addressed after thoroughly reviewing the current literature on a given issue. This stage is essential because it enables the creation of research questions that aim to fill in the gaps and overcome the shortcomings of earlier studies in order to further our understanding of the subject. By identifying these gaps, we may also obtain insights into prospective paths for additional studies and initiatives that might add to the body of knowledge on the topic.

The first block of authors presented in the previous section has noted that the majority of merger transactions are motivated by efficiency considerations and that those driven by technological

synergies tend to result in improved innovation outcomes after the merger, indicating the creation of value. However, the authors did not inquire about the impact of multiple sources of synergy on the probability of transaction manifestation and the underlying mechanisms involved. Specifically, it remains unclear how the presence of overlapping technologies and competing firms affects the likelihood of mergers and acquisitions, and how different forms of synergy interact to influence the outcome of such transactions.

Furthermore, an area of investigation that has yet to be well investigated is the possible creation of a self-perpetuating cycle in which corporations become reliant on external acquisitions as the returns from internal innovation initiatives shrink. This phenomenon could be caused by a variety of circumstances, including a shift in resources towards sales expansion, a loss of motivation among in-house engineers, and the difficulties of integrating a growing portfolio of acquired enterprises. As a result, organizations may become trapped in a loop in which they must constantly acquire new companies in order to maintain their innovative performance, at the price of building internal competencies and resources. Hence, it is imperative to comprehend whether strategic deals are a result of research and development or vice versa.

3 METHODS

This chapter describes the methods adopted during the course of this research.

3.1 DATA COLLECTION

The choice to focus on the pharmaceutical industry for this empirical study is motivated by its inherent characteristics and recognition as one of the most profitable sectors within manufacturing. Furthermore, it is a highly innovative and dynamic sector that plays a crucial role in improving public health and driving economic growth. Pharmaceutical companies are under constant pressure to extensively invest in research and development efforts with the goal of creating new drugs and technologies. However, many businesses turn to mergers and acquisitions in order to acquire new technology, goods, and skills, due to rising costs and lengthened development periods. In light of this, the pharmaceutical business provides a rich environment for investigating the interplay between R&D and M&A interact. The best way for pharmaceutical firms to become more profitable and larger is through internal research, development, and innovation. However, there have been times in the industry's history when innovation was unable to guarantee for the majority of companies growth rates comparable to those of their more successful rivals or of businesses in other quickly expanding sectors of the manufacturing industry, endangering the trust of their investor base (Achilladelis & Antonakis, 2001).

Through the use of the Orbis intellectual Property database, I sampled all pharmaceutical companies from both Europe and North America (US and Canadian). The selection process involved the use of the European Classification of Economic Activities (NACE Rev. 2) and the North American Industry Classification System (NAICS 2017) to classify the companies. The primary code used for the European firms was 21 (Manufacture of basic pharmaceutical products and pharmaceutical preparations), while for the US and Canadian firms, the primary code was 325412 (Pharmaceutical Preparation Manufacturing).

The period I took into consideration for this study is six-year long, precisely from 2015 to 2020. This time frame enabled the construction of a panel dataset consisting of over 60,000 companies and 362,000 companies/years observations. The dataset was carefully curated to ensure that it

represented a comprehensive and diverse sample of pharmaceutical firms from Europe and North America, providing valuable insights into the industry.

As articulated in the previous chapter, the definition of M&As is characterized by a wide-ranging scope. Nevertheless, the present study's scope is confined to completed-to-date acquisitions and mergers, as per the strict definition of these terms.

Another crucial point of clarification pertains to the methodology employed in estimating the value of portfolios, as it is only when a portfolio is sold that its value can be unequivocally determined. In this study, the Orbis Intellectual Property database provides the estimated valuation, which is derived from an algorithm developed by IP Business Information B.V. The valuation model is structured into four macro classes, which contribute to the final valuation as follows. Firstly, the *assignee* category considers the revenue size of the assignee and the number of patent families per employee. Secondly, *market factors* are considered, including the number of patents in the International Patent Classification class, the filling jurisdiction covered, and the GDP per family of the country. Thirdly, *technology quality* is evaluated based on the number of citations, the number of independent claims, and the transferability to different industries. Lastly, *legal events* are incorporated into the valuation model, taking into account factors such as patent maturity, global or local filing, validity in specific countries, procedural state, and grant lag.

3.2 VARIABLES' DEFINITION

The subsequent sections will provide a clear definition of the variables employed in this study. The dependent variable will be presented first, followed by the independent variables for enhanced clarity. A tabular summary will be furnished upon conclusion for the purpose of facilitating a more efficient and effective understanding.

3.2.1 DEPENDENT VARIABLE

The selection of the dependent variable was made to determine the likelihood of a firm's status as an acquirer. Therefore, it is denoted by a binary variable that can take on two distinct values, namely 0 or 1. A value of 0 denotes that the firm under consideration did not acquire any company during the particular year being observed. In contrast, a numerical value of 1 denotes

that the company engaged in a merger or acquisition deal as the acquiring party within the corresponding year.

3.2.2 INDEPENDENT VARIABLES

Conversely, the independent variables under investigation focused on the fluctuations in performance and/or innovation levels of a specific year-firm pairing. The variables under consideration are *'Assets'*, which pertains to the natural logarithm of a firm's total assets; *'R&D'*, which denotes the natural logarithm of R&D expenses; *'ROA'*, which refers to the return on assets, computed as the pre-tax profit divided by the total assets of the company; and *'Portfolio value'*, which indicates the mean value that the patents' portfolio of a given company had in a specific year.

Table 3.1 Description and descriptive statistics of main variables.

Variable	Description	Mean	St. Dev.
ACQUIRER	Dummy that takes the value of 1 if a firm has been a bidder in an M&A deal; it is the dependent variable	0.0007	.02647
Assets	Logarithm of a firm's total assets	6.9233	3.9229
R&D	Logarithm of R&D expenses	9.5085	2.5979
ROA	Return on assets	- .5788	752.6348
Portfolio value	Average value of the patents of a company	47,668.59	471,752.9

3.3 ECONOMETRIC ANALYSIS

The present study involved the development of a panel structure for the dataset under investigation. This was achieved through the integration of three distinct variables, namely the country/world region of the firm's origin, the year of analysis, and a unique alphanumeric identifier assigned to each company. The panel structure thus constructed enabled the examination of the dataset over time and across different geographical locations, while also facilitating the

identification of individual firms within the dataset. This approach allowed for a comprehensive and precise analysis of the data, which is essential for gaining a deeper understanding of the underlying phenomena.

In order to establish the correctness of the relationship between two variables, namely the probability of being an acquirer and the lagged portfolio value, I conducted an econometric analysis. In particular, I used a linear probability model, which involves the regression of the aforementioned probability on the lagged portfolio value. The present study enabled me to conduct an investigation into the potential association that exists between multiple independent factors and the probability of a particular outcome occurring, utilizing the employed model. The LPM is a widely used statistical methodology that facilitates a clear, straightforward, and intuitive comprehension of the impacts of various factors on the probability of an occurrence. This model is frequently utilized in empirical research to estimate the probability of a binary outcome, such as a yes or no response (i.e., 0 or 1), based on a set of explanatory variables. The LPM is particularly useful in situations where the relationship between the outcome and the explanatory variables is expected to be linear, and where the focus is on the magnitude and direction of the effects of the explanatory variables on the outcome.

More formally, I estimate the model:

$$Y_{it} = \alpha_i + \beta_1 Portofolio\ value_{t-1} + \gamma X_{it-1} + \mu_i + \tau_t + \varepsilon_{it}$$

In which Y is the dummy taking the value of 1 if a given firm has acquired another enterprise in year t, and X is a vector of control variables (Assets, R&D, ROA), and τ year dummies.

By employing this model, which I estimate both as random effects as well as fixed effects, I have been able to gain a more comprehensive understanding of the complex dynamics at play and draw more robust conclusions from my analysis, which I will present in the following sections.

4 RESULTS

This chapter is dedicated to presenting the findings derived from the actual analysis.

4.1 RELATIONSHIP BETWEEN R&D AND M&AS

Blonigen and Taylor (2000) proposed a theory that posits that firms face a trade-off between pursuing internal development and M&As as growth strategies. This theory suggests that firms must choose between these two strategies as they are mutually exclusive. In other words, firms do not simultaneously pursue internal development and M&As to achieve growth objectives. From a strategic standpoint, one perspective posits that a firm is faced with a critical decision regarding the most effective means of achieving innovation. Specifically, the firm must weigh the benefits and drawbacks of either cultivating innovation internally or pursuing external opportunities through the acquisition of firms that have already achieved innovative breakthroughs. This decision carries significant implications for the firm's long-term success and competitive advantage within its industry. Given the veracity of this statement, it can be argued that companies that exhibit a high level of innovation, as evidenced by their extensive patent portfolio and corresponding market value, may not necessarily benefit from engaging in an M&A transaction.

In this section, we present the results of the regression analyses that were previously explicated. The findings of both random as well as fixed effects panel models are displayed in Table 4.1.

The results in column 4.1.1 of the study indicate a statistically significant positive parameter estimate, which suggests the presence of a direct and positive association between the likelihood of a firm acting as an acquirer and the possession of a higher level of intellectual property stock. This finding underscores the importance of intellectual property as a valuable asset for firms seeking to engage in acquisition activities. It can be posited that companies possessing a more substantial patent portfolio, which serves as a proxy for their elevated level of innovation, may exhibit a greater propensity to participate in bidding activities in comparison to their counterparts with relatively lower innovative capabilities. Moreover, in order to delve into the intricacies of the internal workings of the identical organization across several years, the regression analyses were replicated with firm fixed effects, thereby producing the outcomes that are expounded upon in section 4.1.2.

Table 4.1 Results of regressions.

	(4.1.1) **Random effects**	**(4.1.2)** **Fixed effects**
Portfolio value	4.06e-08***	1.74e-07***
	(3.95e-09)	(2.59e-08)
Assets	.0089***	-.0025
	(.0027)	(.0062)
R&D	-.0001	.0009
	(.0031)	(.0069)
ROA	-.0001	.0001
	(.0002)	(.0002)
R-squared	0.1391	0.1164
No. Observations	2,030	2,030

Dependent variable = Acquirer

*, **, *** are significantly different from zero at the 10, 5, or 1% levels, respectively.

The findings of this study suggest that there exists a positive correlation between the value of a firm's patent portfolio and the probability of it engaging in a merger and acquisition (M&A) transaction. In other words, firms with a greater value of patents are more likely to pursue M&A deals both in cross-section as well as longitudinally. The aforementioned statement posits that companies are inclined to embark on M&As when they possess a larger quantity of patents, which is indicative of a more robust internal innovation profile. This implies that firms with a greater number of patents are more likely to engage in M&A activities as a means of expanding their intellectual property portfolio and enhancing their innovative capabilities.

The combination of these two models does not entirely reject the classical theory. As a matter of fact, during the period of 2015 to 2020, it was observed that in the pharmaceutical industry, firms with a greater innovation stock were more likely to act as bidders. Additionally, it was found that firms with a higher value of patent portfolio were more likely to initiate an M&A process. It can

be then inferred that companies possessing a greater innovation stock are more inclined to act as bidders.

The possibility of reverse causality leads to a significant inquiry associated with the outcomes that have been observed, namely, whether the larger and superior patent portfolios of firms drive acquisitions, rather than those being a result of acquisitions. While acknowledging the possibility of inconclusive evidence, I endeavored to mitigate this issue by utilizing a Granger Causality methodology.

The study involved performing a regression analysis to examine the relationship between the likelihood of acquisition in a given year *t* and the quality of patent portfolios in the preceding year *t-1*. Additionally, the acquirer dummy variable from the previous year Y_{t-1} was included as a covariate in the analysis. The results, as illustrated in Table 4.2, provide a foundation for the idea that a significant and worthwhile accumulation of patents is suitable to enhance the probability of a company assuming the role of an acquirer. Although the absence of reverse causality cannot be fully established, the aforementioned findings provide valuable insights into the correlation between the quality of a firm's patent portfolio and its likelihood to engage in acquisitions.

Table 4.2 Results of regressions with Granger Causality.

	(4.2.1)	**(4.2.2)**
	Random effects	**Fixed effects**
Portfolio value	3.25e-08***	1.82e-07***
	(3.16e-09)	(2.56e-08)
Acquirer	.1565***	-.1537***
	(.0213)	(.0227)
Assets	.0093***	-.0002
	(.0023)	(.0061)
R&D	-.0004	.0005
	(.0026)	(.0068)
ROA	-.0001	5.31e-06
	(.0002)	(.0002)
R-squared	0.1593	0.1038
No. Observations	2,030	2,030

Dependent variable = Acquirer

*, **, *** are significantly different from zero at the 10, 5, or 1% levels, respectively.

4.2 ECONOMIC SIGNIFICANCE

Having provided empirical evidence that hints at the existence of a relationship between internal innovation and M&A deals, I proceed by trying to explain the economic implications of this result.

In order to extensively comprehend the relationship between the probability of a company becoming an acquirer and the growth in the value of its patents, the following formula is employed:

$$Effect = Coeff * St.Dev$$

Specifically in this study, the formula becomes:

$$Effect_{re} = (4.06e - 08) * 471{,}752.9 = 0.019 \qquad (1)$$

and:

$$Effect_{fe} = (1.74e - 07) * 471{,}752.9 = 0.082 \qquad (2)$$

The results (1) indicate that in the first regression, a rise of one unit in the standard deviation of the mean value of patents results in a 1.9% increase in the likelihood of it being an acquirer, compared to the previous probability. This implies that, according to the dataset used, a company possessing an additional unit relative to another enterprise exhibits has nearly a 2% higher chance of being a bidder. Additionally (2) shows the likelihood of a company engaging in M&A activities based on the value of its patent portfolio. In this instance, a modification in a single unit of value increases the probability of assuming the role of a bidder by as much as 8.2%.

5 DISCUSSION

The primary objective of this particular chapter is to provide a comprehensive and cohesive summary of the most significant discoveries and outcomes of the research study. By doing so, this section aims to offer a clear and concise understanding of the study's outcomes and the implications that can be drawn from them.

Focusing on the pharmaceutical industry, innovation emerges as a key success factor in the industry's dynamic environment, which is characterized by changing market demands, stringent regulatory frameworks, and intense competition (Prata et al., 2017). Furthermore, based on a 2018 article from McKinsey, it can be inferred that mergers and acquisitions have served and are likely to continue serving as the predominant means through which established pharmaceutical firms attain success.

The findings of this study, which had been discussed earlier, corroborate the assertion made by McKinsey as well. Notably, it is well clear the role that the connection between M&As and innovation strategies plays in pharmaceutical companies.

5.1 UNDERSTANDING OF THE OUTCOMES

The findings explicated in the preceding chapter are substantiated by several scholarly investigations, as evinced in the "Literature review" section. This review of relevant literature has revealed a wealth of research that corroborates the outcomes presented in the previous chapter, thereby providing additional support to the validity and reliability of the study's results. Not only are companies likely to engage in M&A transactions, but the decision to enter is also influenced by the level of innovation within the company, and not the other way around.

In the event that a firm's patent portfolio value exceeds that of its competitors in the same year, as well as its value in preceding years, there is an amplified probability of the firm transitioning into a bidder. This phenomenon can be attributed to the fact that a firm's patent portfolio is a crucial determinant of its competitive advantage, a higher value of which signifies a greater potential for generating revenue and achieving market dominance (Prata et al., 2017). As such, firms with a superior patent portfolio are more likely to engage in strategic acquisitions and mergers, as a means of expanding their intellectual property assets and consolidating their market position. The process

of regularly assessing a firm's positioning in relation to its level of innovation can yield valuable insights. By engaging in such an evaluation, a company can gain a deeper understanding of its current standing in the market and how it compares to its competitors.

5.2 IMPACTS ON THE FUTURE OF THE INDUSTRY

The forthcoming insights aim to facilitate comprehension of the potential impacts that these conclusions may engender within the industry.

First, the pharmaceutical industry can experience an increase in strategic deals as a result of new drug discoveries being made. Those deals can lead to a more attractive industry for many smaller players, accelerating the process of drug discovery and development. Furthermore, M&As provide pharmaceutical companies with access to supplementary knowledge or resources, which can facilitate the expeditiousness of drug discovery and development procedures. This can lead to a reduction in the time required to introduce new medications to the market, thereby facilitating more efficient resolution of unfulfilled medical requirements.

Second, being the process of diversifying research portfolios in the pharmaceutical industry a crucial matter, it is then so important to innovate extensively to be able to acquire firms that possess distinct therapeutic focuses or areas of expertise. In fact, diversification has the potential to mitigate risks that are linked to dependence on a single drug or therapeutic domain and facilitate the promotion of the firm’s long-term sustainability.

Third, M&As can also serve as a means for pharmaceutical companies to gain a competitive edge by broadening their market presence. Being able to enter an M&A process can allow a firm to gain entry into new geographic regions, customer segments, or distribution channels.

Lastly, it is also important to consider the efficiency side M&As can lead to potential cost savings and operational efficiencies. This can be attributed to the realization of economies of scale, streamlining of overlapping functions, and elimination of redundant activities. This can potentially allocate resources towards a greater investment in research and development as well as innovation.

5.3 FUTURE RESEARCH

In this section, I will propose some potential paths of investigation that further studies may find to be insightful in pursuing.

Further investigation can focus on studying whether and how the existing relationship found in the pharmaceutical industry can be also found in other sectors. Second, I have shown that this relationship has a direction, in fact, the patent stock leads to the probability of an M&A deal. Exploring whether this phenomenon happens in all the life cycles of the industry would be important. Finally, additional theoretical research in the future can help determine whether and how different sources of synergy affect the likelihood of transaction incidence, perhaps capturing the tension between rivalry in the product market and complementarities due to overlapping technology.

6 CONCLUSIONS

The present study endeavors to examine the existence of a positive or negative relationship between the innovation level of a company and its likelihood of being a bidder. The research employs an extensive dataset that aggregates data from more than 60,000 distinct pharmaceutical enterprises, covering the period of time from 2015 all the way up to 2020.

The outset of this inquiry involved a comprehensive examination of the extant literature, which brought to light certain domains that have not been sufficiently scrutinized, as well as the ongoing debate between conventional approaches and contemporary scholarly revelations. The classical perspective contends that there is a dichotomy between in-house research and development and mergers and acquisitions. However, contemporary research indicates that there exists a correlation between the two, despite their inherent disparities.

The study's design and methodology facilitated a thorough investigation of the research question. The utilization of the linear probability model has facilitated the identification of a favorable correlation between a firm's degree of innovation and its inclination to engage in mergers and acquisitions. This association holds true for individual businesses over the course of numerous years, as well as for separate organizations operating within the same year. The results also suggest that the size of a company's patent inventory has a significant influence on the potential of the company acting as an acquirer in mergers and acquisitions.

The application of Granger Causality has facilitated the identification of the preexisting patent portfolio as the causal factor that heightens the likelihood of participation in a merger or acquisition, as opposed to the reverse causality that may have been hypothesized.

Furthermore, the present study constitutes a significant addition to the academic domain and offers recommendations for future inquiry.

In conclusion, it is recommended that further research be conducted focusing on studying whether and how the existing relationship found in the pharmaceutical industry can be found in other sectors. It has been shown that patent stock leads to the probability of an M&A deal, and further theoretical research can help determine whether and how different sources of synergy affect the likelihood of transaction incidence. This has the potential to effectively capture the dynamic

interplay between competitive forces in the product market and the synergistic effects arising from shared technological capabilities.

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SUMMARY

The pharmaceutical sector has experienced a notable increase in mergers and acquisitions (M&As) among its key players in recent times. The strategic significance of M&As as a tool for achieving business objectives and navigating the intricate landscape of the pharmaceutical industry is being increasingly acknowledged by pharmaceutical companies. Consequently, the pharmaceutical industry is currently experiencing substantial changes that are altering the competitive landscape and future outlook of companies operating within the sector. The recent trend of M&As can be attributed to various factors such as the desire for portfolio diversification, expansion into untapped markets, cost synergies, and improved innovation capabilities.

In an effort to comprehend the impact that innovation also plays in a firm's environment, prior research has shown that it is essential for fostering economic development in highly competitive contexts (Geroski & Machin, 1992). Concurrently, M&As have surfaced as strategic instruments for attaining success in

diverse sectors. According to the traditional paradigm, there exists an alternative interaction between research and development (R&D) and M&As.

The objective of this thesis is to undertake a critical evaluation of the reliability of the aforementioned theory in the pharmaceutical industry. The aim is to provide insights into the interplay between these two strategies and their combined influence on the efficacy and competitiveness of pharmaceutical firms.

The present study endeavors to examine the existence of a positive or negative relationship between the innovation level of a company and its likelihood of being a bidder. The research employs an extensive dataset that aggregates data from more than 60,000 distinct pharmaceutical enterprises, covering the period of time from 2015 all the way up to 2020.

The primary objective of this study is to investigate the potential correlation between an organization's level of innovation and its likelihood to participate as a bidder in acquisition activities. This study expands its analysis beyond the internal dynamics of the firm by examining the wider industry context and competitive landscape. It

acknowledges the potential impact of these external factors on the likelihood of engaging in acquisitions. This study aims to investigate the complex relationship between innovation, industry dynamics, and competitive environments through a comprehensive approach. The objective is to gain a more detailed comprehension of the factors that motivate firms to engage in acquisition activities. The present investigation's results enhance the current pool of information regarding strategic decision-making within the framework of mergers and acquisitions.

During the first chapter, I established the groundwork for the investigation by diving into the fundamental themes and performing a comprehensive examination of the current body of literature. The objective of the chapter is to identify any gaps or unaddressed aspects within the existing body of knowledge and in this way help to establish the rationale and objectives for the research.

In chapter two the focus shifts on the methodological aspects of the study, providing a detailed account of the research design and data collection methods employed. Special emphasis is placed on defining the variables used in the analysis, ensuring clarity and consistency in measurement.

The third chapter unveils the findings of the empirical analysis that was carried out. Through rigorous data analysis techniques, key findings and insights are extracted, shedding light on the relationship between innovation, M&As, and their impact on the pharmaceutical industry. This chapter additionally scrutinizes the economic import of the discoveries, underscoring the pragmatic ramifications and plausible advantages for the stakeholders of the industry.

Chapter four delves into the interpretation of the results, providing a comprehensive discussion and analysis of the findings. This chapter also highlights areas that need more study in order to increase the understanding of the intricate processes at work, pointing forth potential directions for future investigation.

Finally, the fifth chapter serves as a concluding chapter by summarizing the major findings and formulating general conclusions in light of the analysis carried out throughout the study. This chapter encapsulates the main contributions of the research, discussing their implications. This serves as a comprehensive summary that offers closure to the study, while also laying the groundwork for future research directions in the field.

Collectively, these five distinct chapters investigate the relationship between innovation, mergers and acquisitions, and the pharmaceutical industry, and form a cohesive framework. This master's thesis endeavors to enhance the existing body of knowledge in this domain by scrutinizing extant literature, performing empirical analysis, and interpreting the findings to provide valuable insights.

Focusing on the pharmaceutical industry, innovation emerges as a key success factor in the industry's dynamic environment, which is characterized by changing market demands, stringent regulatory frameworks, and intense competition (Prata et al., 2017). Furthermore, based on a 2018 article from McKinsey, it can be inferred that mergers and acquisitions have served and are likely to continue serving as the predominant means through which established pharmaceutical firms attain success.

The findings of this study show that not only are companies likely to engage in M&A transactions, but the decision to enter is also influenced by the level of innovation within the company, and not the other way around.

In the event that a firm's patent portfolio value exceeds that of its competitors in the same year, as well as its value in preceding years, there is an amplified probability of the firm transitioning into a bidder. This phenomenon can be attributed to the fact that a firm's patent portfolio is a crucial determinant of its competitive advantage, a higher value of which signifies a greater potential for generating revenue and achieving market dominance (Prata et al., 2017). As such, firms with a superior patent portfolio are more likely to engage in strategic acquisitions and mergers, as a means of expanding their intellectual property assets and consolidating their market position. The process of regularly assessing a firm's positioning in relation to its level of innovation can yield valuable insights. By engaging in such an evaluation, a company can gain a deeper understanding of its current standing in the market and how it compares to its competitors.

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individual businesses over the course of numerous years, as well as for separate organizations operating within the same year. The results also suggest that the size of a company's patent inventory has a significant influence on the potential of the company acting as an acquirer in mergers and acquisitions.

The application of Granger Causality has facilitated the identification of the preexisting patent portfolio as the causal factor that heightens the likelihood of participation in a merger or acquisition, as opposed to the reverse causality that may have been hypothesized.

Those results can have several implications within the industry. First, the pharmaceutical industry can experience an increase in strategic deals as a result of new drug discoveries being made. Those deals can lead to a more attractive industry for many smaller players, accelerating the process of drug discovery and development. Furthermore, M&As provide pharmaceutical companies with access to supplementary knowledge or resources, which can facilitate the expeditiousness of drug discovery and development procedures. This can lead to a reduction in the

time required to introduce new medications to the market, thereby facilitating more efficient resolution of unfulfilled medical requirements.

Second, being the process of diversifying research portfolios in the pharmaceutical industry a crucial matter, it is then so important to innovate more and more to be able to acquire firms that possess distinct therapeutic focuses or areas of expertise. In fact, diversification has the potential to mitigate risks that are linked to dependence on a single drug or therapeutic domain and facilitate the promotion of the firm's long-term sustainability.

Third, M&As can also serve as a means for pharmaceutical companies to gain a competitive edge by broadening their market presence. Being able to enter an M&A process can allow a firm to gain entry into new geographic regions, customer segments, or distribution channels.

Lastly, it is also important to consider the efficiency side M&As can lead to potential cost savings and operational efficiencies. This can be attributed to the realization of economies of scale, streamlining of overlapping functions, and elimination of

redundant activities. This can potentially allocate resources towards a greater investment in research and development as well as innovation.

Future research can then focus on studying whether and how the existing relationship found in the pharmaceutical industry can be also found in other sectors. Second, I have shown that this relationship has a direction, in fact, the patent stock leads to the probability of an M&A deal. Exploring whether this phenomenon happens in all the life cycles of the industry would be important. Finally, additional theoretical research in the future can help determine whether and how different sources of synergy affect the likelihood of transaction incidence, perhaps capturing the tension between rivalry in the product market and complementarities due to overlapping technology.