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Change in companies' investment decisions before Mergers and Acquisitions in the Healthcare Industry

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Abstract

Considering the field of mergers and acquisitions, many studies have been conducted on the factors that influence these deals and how. However, there are still some aspects that have not been analysed in depth. This work aims to examine whether, in the healthcare sector, the investment decisions of companies that are close to a merger or an acquisition change in the years before the deal.

Chapter 1

Introduction

In today's economy many companies seek to grow and expand, and this is mainly done through mergers and acquisitions (M&A). The number of M&A deals has increased considerably during the last 30 years, reaching a peak in 2021. According to Statista, just in 2022 almost fifty thousand deals¹ were completed worldwide with a total value of 3.4 trillion USD², showing how M&A are nowadays a common phenomenon.

The United States are, and have always been, leader in the M&A field with a total value of around 2.6 trillion USD in 2021, then decreased to 1.6 trillion in 2022³. The second place is now occupied by China, which replaced the United Kingdom, thanks to a significant increase in the merger market over the last twenty years.

Many studies are present in literature related to the factors that influence the decisions of firms to merge or to acquire. Most of them focus on agency and neoclassical theories, as

¹ Statista Research Department (2023). *Volume of M&A deals globally 1985-2023*. Statista, <https://www.statista.com/statistics/267368/number-of-mergers-and-acquisitions-worldwide-since-2005/> . Accessed in November 2023.

² Statista Research Department (2023). *Value of M&A deals globally 1985-2023*. Statista, <https://www.statista.com/statistics/267369/volume-of-mergers-and-acquisitions-worldwide/> . Accessed in November 2023.

³ Statista Research Department (2023). *Value of M&A deals in the U.S. 2006-2022*. Statista, <https://www.statista.com/statistics/420990/value-of-merger-and-acquisition-deals-usa/> . Accessed in November 2023.

the works of Jovanovic and Rousseau (2002)⁴ and Kropf and Robinson (2008)⁵, to name some of the most relevant.

However, only few examined the relationship between investments in innovation and the decisions of firms to undertake such transactions. Some of the most relevant works in this area are the ones by Amit Seru (2010)⁶, G. M. Phillips and A. Zhdanov (2013)⁷, and some others which will be described in detail in the following chapters.

This work attempts to fill a bit the gap in literature on this topic by analysing if the decisions that firms in the healthcare industry take, change before mergers and acquisitions. In particular, it is examined how the behaviour of target companies changes in the years preceding the deal, with respect their investments in research and development (R&D). This area of study is particularly interesting because investments in innovation are crucial for firm competitiveness and because, by examining whether companies' investment decisions change, it might be possible to anticipate if some companies are likely to become targets of transactions, independently from the announcement date.

The analysed data come from fifty selected deals and the main statistical tool used has been the multiple linear regression. The model has been constructed using research and development as the dependent variable and analysing the impact that some independent variables have on it, in particular total assets, and cash. The analysis focuses on the research and development expenses of the three years preceding the transaction, with the

⁴ Jovanovic B., Rousseau P. L. (2002). *The Q-Theory of Mergers*. American Economic Review, 92(2), 198-204.

⁵ Rhodes-Kropf M., Robinson D. T. (2008). *The Market for Mergers and the Boundaries of the Firm*. The Journal of Finance, 63(3), 1169-1211.

⁶ Seru A. (2010). *Firm Boundaries Matter: Evidence from Conglomerates and R&D Activity*. Journal of Financial Economics, 111(2), 381-405.

⁷ Phillips G. M., Zhdanov A. (2013). *R&D and the Incentives from Merger and Acquisition Activity*. Review of Financial Studies, 26(1), 34-78.

independent variables relative to one year before the R&D's one. The purpose is to examine whether the influence of the regressors on R&D expenses, changes throughout those years.

The results obtained suggest that total assets and cash influence R&D investment decisions in a different way the closer the deal is. The analysis highlights that the cash regressor becomes not significant only in the last year before the transaction with a negative sign, whereas the total assets variable is significant and positively influences the R&D expenses of the two years preceding the deal.

The general composition of the work is described below.

The work starts with a broad introduction to the concept of mergers and acquisitions in Chapter 2, *Mergers and Acquisitions*, very general but helpful to understand the concepts discussed in the following chapters. After the analysis of the reasons that drive companies to merge and the study of the different types of M&A, it is reported the evolution of these deals throughout the years. Then, the text proceeds in Chapter 3, *Background*, with the illustration of some previous studies that have been done in this field, and a general description of the healthcare industry, on which the study will focus. Chapter 4, *Dataset Analysis*, after an overview of the database, provides a brief description of the dataset used to conduct the analysis with an explanation of the process that led to the selection of the final sample. Then Chapter 5, *Methodology and Results*, illustrates the regression model used and the results obtained. Finally, Chapter 6, *Conclusions*, draws general conclusions to the work and provides some inputs for future analyses in the field.

Chapter 2

Mergers and Acquisitions

In this chapter a general introduction to the concept of mergers and acquisitions is provided.

Definition of Mergers and Acquisitions

The term Mergers and Acquisitions, usually abbreviated as M&A, describes the consolidation of two or more companies into a new one. Although these two terms are often used as synonyms, as in both cases two firms that previously had separate ownership are brought together, they are slightly different.

A merger is a combination of two firms that form a new company. Usually after a negotiation process, the acquiring party obtains assets and liabilities of the target, and the two firms form a new legal entity. In this case, both companies are likely to be favourable to the merger which they think will be beneficial for them.

On the contrary, the term acquisition (or takeover) stands for the purchasing process of a company, usually called target, by another one, the acquirer. The acquiring company completely absorbs the other, generally by getting the majority stake. Acquisitions can be classified as friendly or hostile. In the first case the board of the acquired firm is favourable to the acquisition which it sees as a growth opportunity and for this reason it tries to be as attractive as possible to the eyes of the acquiring company. This is usually the case of small successful firms which do not have enough capital to grow and expand

on their own. Instead, unfriendly takeovers occur when the target company is not willing to be acquired. They are also called hostile takeovers.

Thanks to tax advantages and by not involving any acquisition premium, mergers are typically preferred to acquisitions.

Reasons behind Mergers and Acquisitions

In today's economy, M&A are a very important business tool to grow faster than competitors. Beside the growth factor, there are many different reasons that bring a company to merge or to acquire, some of the most significant are here reported.

The first relevant aspect that drives firms into M&A deals is the creation of synergies. If there is more value after the deal, than the sum of the two separate values of the target and the acquiring company before the transaction, it means that synergies are created through the process. The different types of synergies created can be numerous.

First of all, a company may look for operating synergies and to this end it can create economies of scope which occur when a company can produce a wide range of different products and services by using the same inputs. An example can be the use of the same distribution channels, input materials, or marketing for different outputs.

Operating synergies may also be reached with the creation of economies of scale. These are the cost savings related to the reduction of the average unit cost, due to the spread of fixed costs over a large number of goods. For example, plants and equipment costs.

The creation of financial synergies is also an important aspect to be considered. It consists of the cost of capital reduction resulting from the combination of one or more companies that have uncorrelated cash flows.

Another reason behind M&A deals is the search for diversification, especially in conglomerate mergers. Large and diversified firms are less likely to go bankrupt respect a company that is less diversified but with the same degree of leverage. Diversified companies can thus increase their debt and enjoy greater tax savings.

One more aspect to be considered is the desire to increase market power. To this end, companies integrate vertically, by taking direct control of different stages of the production cycle, acquiring either a customer or a supplier.

Another relevant factor that can influence M&A decisions is the pursuit of R&D improvement. This was one of the main causes behind the consolidation of the pharmaceutical industry during the nineties⁸.

Sometimes mergers are driven by behavioural reasons, the CEO might be overconfident and acquire firms driven by his hubris, which according to the Cambridge Dictionary is “*an extreme and unreasonable feeling of pride and confidence in yourself*”⁹. In his 1986 paper¹⁰, Roll argued that sometimes CEO believe in their ability to manage so much that they chase even not efficient mergers.

According to a study conducted by Statista, in 2021 the main driver of merger and acquisition deals worldwide was the increase in operational capabilities, followed by increasing Environmental, Social and Governance (ESG) results¹¹.

⁸ Gaughan P. A. (2007). *Mergers, Acquisitions, and Corporate Restructurings* (4th ed.). John Wiley & Sons.

⁹ Cambridge dictionary’s definition.

¹⁰ Roll R. (1986). *The Hubris Hypothesis of Corporate Takeovers*. *The Journal of Business*, 59(2), 197-216.

¹¹ Statista Research Department (2022). *Main strategic drivers for M&A deals worldwide in 2022*. Statista, <https://www.statista.com/statistics/953278/main-strategic-drivers-behind-mergers-and-acquisitions-worldwide/> . Accessed in November 2023.

Different types of Mergers and Acquisitions

M&A deals can be organized in many ways. The four basic types of mergers are here reported.

Vertical mergers are deals involving two companies that operate in different phases of the production process, consolidating the supply chain, for example a company producing printing machines merge with a company which produces printer cartridges. A famous case of this type of merger is the acquisition of Pixar by Walt Disney in 2006. Both operated in the movie production industry, Disney had great distribution networks and acquired Pixar for its proprietary technology in animated design content.

Horizontal integration instead occurs when two companies producing similar, or even the same good, combine, increasing market power and creating powerful scale economies. This type of merger is quite dangerous because it has an adverse competitive effect in the market, at the expenses of the customers. That is why there are some rules and general guidelines imposed by antitrust authorities. An example can be the merge of Hp and Compaq in 2011.

Congeneric, or concentric, deals involve the merge of two companies which, despite producing different products, share the same distribution channels or production processes. A well-known example is the merge of Kraft Foods and H. J. Heinz in 2015. The two food companies merged mainly to exploit the cost synergies arising from the economies of scale generated.

Finally, a conglomerate merger usually occurs when two completely different firms with unrelated business activities join to diversify their businesses. One of the most famous examples of this type of merger, is the acquisition in 2017 of Whole Foods Market, the largest chain of supermarkets in America, by Amazon. While this type of deal was quite popular in the 1960s now it is generally avoided because it is not efficient enough in creating value.

Evolution of Mergers and Acquisitions

The merger and acquisition activity firstly became popular in the United States, but since the mid-20th century it has become a widely used growth tool all around the world. Research has shown that M&A tend to occur in waves, which are periods of high merger activity, followed by periods in which there are fewer transactions. These phases are typically cyclical. Usually, mergers occur in periods when companies are optimistic, have good forecasts about the future, and stock markets are growing. Studies have identified some major waves, each with different characteristics.

First wave (approximately 1897 – 1904)

The first wave is characterised by the consolidation of industries, mainly in the manufacturing and mining sectors, which experienced a great merger activity. The predominance of horizontal mergers in this period led to the creation of large monopolies, which were not effectively prohibited by the Sherman Antitrust Act, and the establishment of industrial leaders.

Second wave (approximately 1916 – 1929)

During the second wave, rather than monopolies, the consolidation of industries resulted in the creation of oligopolies. The predominance of vertical mergers over horizontal ones in this merger wave was due to the presence of more stringent antitrust rules, with the enactment of the Clayton Antitrust Act in 1914. The big stock market crash in October 1929 ended this second wave and was one of the main drivers of the Great Depression that followed.

Third wave (approximately 1965 – 1969)

As a consequence of new further antitrust rules and restrictions that made it difficult for firms to integrate horizontally and vertically, the third wave has been characterised mainly by conglomerate transactions with diversification purposes. As a matter of fact, conglomerates are large corporations that operate in many different industries.

Fourth wave (approximately 1984 – 1989)

The fourth merger period differs from the others for the predominance of hostile takeovers, which are deals that do not have the approval of the board of the target company. Another important feature of this wave is the significantly larger size of the targets, for this reason this wave is sometimes indicated as the *megamergers* wave.

Fifth wave (approximately 1992 – 2000)

Even this wave featured large mergers, but it was characterised by more strategic and less hostile deals. In this period the M&A phenomenon became truly global and worldwide.

Sixth wave (approximately 2003 – 2007)

In the period going from 2003 to 2007, the globalization trend continued to drive the deals, with an increasing role played by private equity buyers. This wave came to an end in 2008 with the financial crisis.

Seventh wave? (2013 onward)

After the period of economic recession that followed the financial crisis of 2008, 2013 showed the first signs of economic recovery, opening the door to a new period of optimism that led to a total value of the deals of nearly 4.8 trillion U.S. dollars in 2015¹². The period of risk aversion tendency and organic growth emphasis that followed the crisis, came to an end.

Then, the worldwide explosion of the COVID-19 pandemic in the beginning of 2020, had initially a strong impact on the merger market, with different consequences all around the world. However, in 2021 a considerable increase in the deal activity was registered¹³,

¹² Institute for Mergers, Acquisitions and Alliances (IMAA). *Number & Value of M&A worldwide*. <https://imaa-institute.org/mergers-and-acquisitions-statistics/>. Accessed in January 2024.

¹³ Tennant F. (2021). *Boom time: riding the seventh great 'M&A wave'*. *Financier Worldwide*, <https://www.financierworldwide.com/boom-time-riding-the-seventh-great-ma-wave>

reaching 5.2 trillion U.S. dollars, with a significant role played by megadeals. Yet, after this brief period, deals volume and values dropped again.

Struggling to keep the pace with 2021, in 2022 the merger market registered a slowdown, totalizing around 50 thousand deals¹⁴ with a total value of 3.4 trillion USD¹⁵. These results however are in line with the years preceding the global pandemic. The setback from 2021 records, is attributable to sentiments of uncertainty and instability mainly coming from geopolitical issues, rising interest rates and inflation, and higher capital costs.

According to a PwC analysis, during the first half of 2023 the situation did not improve. As a matter of fact, the global volume of M&A deals was even lower than in the second half of 2022, recording a reduction of nearly 4%, but still consistent with the levels before COVID-19 pandemic. Even the total value of the deals declined by 12%¹⁶.

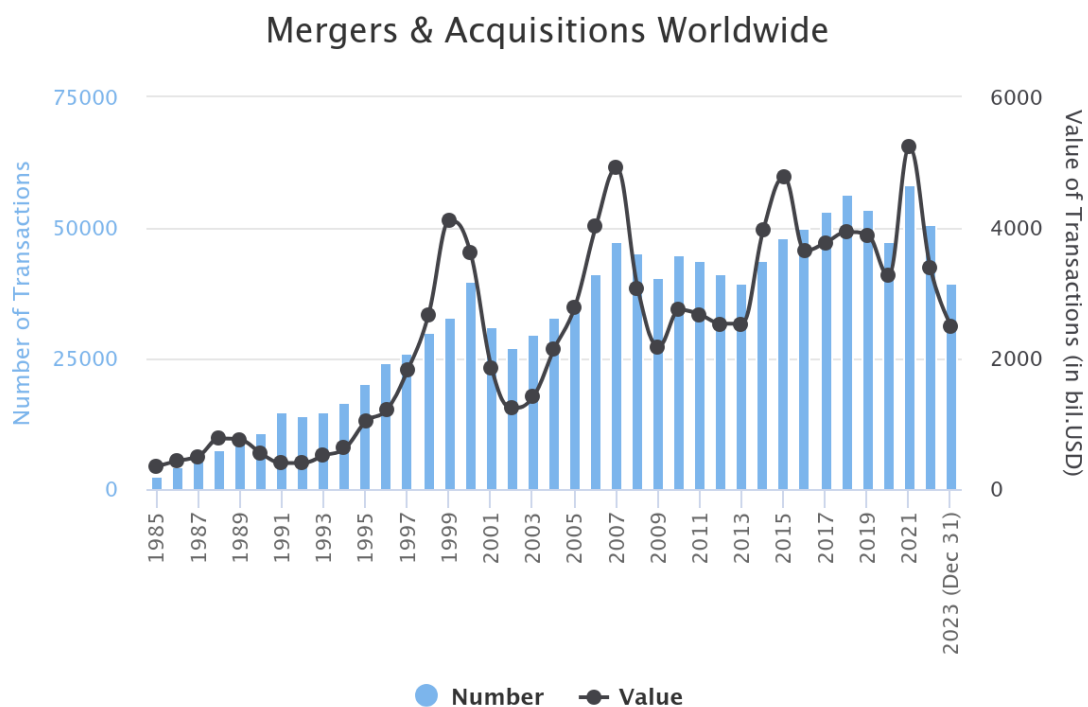
To summarise and clearly visualize the trends just described, the following graph illustrates the total volume and values (in USD billions) of global transactions from 1985 to 2023¹⁷, as of January 4th, 2024.

¹⁴ Statista Research Department (2023). *Volume of M&A deals globally 1985-2023*. Statista, <https://www.statista.com/statistics/267368/number-of-mergers-and-acquisitions-worldwide-since-2005/> . Accessed in November 2023.

¹⁵ Statista Research Department (2023). *Value of M&A deals globally 1985-2023*. Statista, <https://www.statista.com/statistics/267369/volume-of-mergers-and-acquisitions-worldwide/> . Accessed in November 2023.

¹⁶ Pwc (2023). *Global M&A Industry Trends: 2023 Mid-Year Update*. <https://www.pwc.com/gx/en/services/deals/trends/h1-2023.html> . Accessed in November 2023.

¹⁷ Institute for Mergers, Acquisitions and Alliances (IMAA). *Number & Value of M&A worldwide*. <https://imaa-institute.org/mergers-and-acquisitions-statistics/> . Accessed in January 2024.



Source: IMAA analysis; imaa-institute.org

Figure 2.1: Volume and Values of worldwide transactions from 1985 to 2023

Chapter 3

Background

This chapter describes the background and the setting where the analysis was conducted. Moreover, some of the main characteristics of the healthcare industry, which will be the core focus of the study, are illustrated.

Previous studies

Despite a great number of studies conducted on this worldwide phenomenon, only a few have examined the relationship between R&D investments, and the decision of firms to participate in M&A deals, and how pre and post-acquisition innovation investments change.

Most of the existing studies in the field focus on agency and neoclassical theories, based on the Q theory of mergers¹⁸. Just to name some of the most relevant, the theory of Jovanovic and Rousseau (2002)¹⁹ suggests that companies with high Q ratio acquire firms

¹⁸ The Q theory of mergers has its roots in the Tobin's Q theory of investment (Tobin Q is measured as the ratio between market value of a firm and replacement cost of its assets). According to this theory, firms with higher Q ratio should be more active in the merger market, investing more. (Cho S., Chung C. Y. (2022). *Review of the Literature on Merger Waves*. Journal of Risk and Financial Management, 15(10), 1-21.)

¹⁹ Jovanovic B., Rousseau P. L. (2002). *The Q-Theory of Mergers*. American Economic Review, 92(2), 198-204.

with a lower Q, generating larger joint gains. Then, Rhodes-Kropf and Robinson (2008)²⁰ demonstrated that “like buys like”. Their analysis showed that, due to asset complementarity, mergers typically involve companies with similar market-to-book ratio.

However, the number of studies directly analysing the link between the likelihood of acquisitions and R&D is now increasing.

One of the first and most relevant studies on this topic is the one by Seru (2010)²¹ who examined the relationship between R&D and conglomerates, finding out that this type of corporation negatively influences the productivity of resources. By analysing the number of patents that a firm’s research activity generates, he found evidence that conglomerate mergers cause a substantial reduction in targets’ R&D productivity, with fewer innovations. This is explained by the tendency of acquirers to participate in strategic alliances and joint ventures after the merger, outsourcing R&D rather than allocating additional resources to internal R&D.

Evidence from G. M. Phillips and A. Zhdanov (2013)²² showed that firms’ likelihood to carry out R&D and innovate, depends on M&A market and on the level of competition present. Small firms’ investments in innovation are enhanced by an active takeover market, whereas large firms can optimally acquire companies that successfully innovate rather than investing huge amount of money in R&D themselves. This provides a new and different interpretation of the decrease in innovation activity compared to Seru’s one. Small firms may then have incentives to invest more in R&D knowing that they will likely

²⁰ Rhodes-Kropf M., Robinson D. T. (2008). *The Market for Mergers and the Boundaries of the Firm*. The Journal of Finance, 63(3), 1169-1211.

²¹ Seru A. (2010). *Firm Boundaries Matter: Evidence from Conglomerates and R&D Activity*. Journal of Financial Economics, 111(2), 381-405.

²² Phillips G. M., Zhdanov A. (2013). *R&D and the Incentives from Merger and Acquisition Activity*. Review of Financial Studies, 26(1), 34-78.

become attractive merger targets. This effect however is proved to be decreasing with the increase in firm size.

Then, J. Bena and K. Li (2014)²³ further analysed the interactions between M&A and innovation, examining data over the period from 1984 to 2006. Firstly, they showed that, despite acquirers and targets being both active in technological innovations, acquirers are often characterized by lower R&D investments and focus more on having a large patent portfolio. Instead, firms that will likely become targets spend more on R&D but have a relatively small patent output and fewer opportunities to grow, which is compatible with Phillips and Zhdanov's (2013) findings. Then, by studying the effects of technological overlap on the likelihood of firms to merge, they found out that this overlap positively affects merger pair formation, enhancing the innovation output. Considering that sharing similar technology can be an incentive to merge, because it reduces costs by creating economies of scale and scope, they expected this result. However, the effect is lower when product markets are overlapping too. Finally, they also studied the relationship between the ex-post innovation output and the technological overlap before the deal, showing a positive correlation between the two. They found out that acquisitions are enhanced by synergies created by the integration of innovation capabilities.

Frésard, Hoberg and Phillips (2014)²⁴ demonstrated that companies in industries characterised by high research and development levels, are less likely to be involved in vertical transactions. This is consistent with the work of Phillips and Zhdanov (2013)²⁵, which demonstrated that these companies are more likely to be involved in non-vertical,

²³ Bena J., Li K. (2014). *Corporate Innovations and Mergers and Acquisitions*. The Journal of Finance, 69(5), 1923-1960.

²⁴ Frésard L., Hoberg G., Phillips G. (2014). *The Incentives for Vertical Acquisitions and Integration*. Review of Financial Studies.

²⁵ Phillips G. M., Zhdanov A. (2013). *R&D and the Incentives from Merger and Acquisition Activity*. Review of Financial Studies, 26(1), 34-78.

but horizontal, deals. Moreover, they found that firms in patent-intensive industries are more likely to be vertically integrated.

Based on these studies, the scope of this work is to analyse whether firms that become merger targets, change their behaviour and investment strategies in R&D in the years preceding the deal. In particular, some of the items of the financial statements that have a direct impact on R&D investments are taken into consideration, and the focus is on how they change through those years.

Healthcare Industry

General information on the sector

Nowadays the healthcare industry has become extremely important. Among the eleven sectors of the Global Industry Classification Standard (GICS®), in 2023 the healthcare sector was reported to be the third most heavily weighted one worldwide, representing 12.3% of the S&P Global 1200²⁶, and the second in U.S., 13.1% of the S&P 500®²⁷, as of October 31st, 2023.

The sector expenditures have a great impact on the economy, amounting to 16.6% of the gross domestic product (GDP) in 2022 in U.S., followed by Germany 12.7%, and France

²⁶ S&P Dow Jones Indices. *S&P Global 1200 Sector Breakdown*. <https://www.spglobal.com/spdji/en/indices/equity/sp-global-1200/#data> . Accessed in November 2023.

²⁷ S&P Dow Jones Indices. *S&P 500® Sector Breakdown*. <https://www.spglobal.com/spdji/en/indices/equity/sp-500/#data> . Accessed in November 2023.

11.9%²⁸. This percentage is expected to grow even further, it is estimated that in 2030 it will reach nearly 20% of the GDP in U.S., almost six trillion USD²⁹.

Sub-sectors

The healthcare sector includes all the businesses connected with the provision of products and services related to medical care. Some of the most well-known companies that operate in this sector are Pfizer, AstraZeneca, Bayer, and many others. The healthcare industry groups many different sub-industries, including pharmaceuticals, biotechnology, medical equipment and supplies, healthcare facilities, managed healthcare, and others. Some of the most important are here reported.

Even if both pharmaceuticals and biotechnology companies produce drugs, vaccines, and treatment methods, they differ in the way they develop them. Pharmaceutical firms create medicines using chemical synthesis, while biotechnology companies use living organisms and biological processes.

The medical equipment and supplies industry includes all the firms that provide medical devices and equipment as medical appliances, orthopedic and cardiovascular devices, surgical tools as gloves or scalpels, and so on.

²⁸ Statista Research Department (2023). *Health expenditure as a percentage of gross domestic product (GDP) in selected countries in 2022*. Statista, <https://www.statista.com/statistics/268826/health-expenditure-as-gdp-percentage-in-oecd-countries/>. Accessed in November 2023.

²⁹ Vankar P. (2023). *U.S. health expenditure as percent of GDP 1960-2021*. Statista, <https://www.statista.com/statistics/184968/us-health-expenditure-as-percent-of-gdp-since-1960/>. Accessed in November 2023.

The healthcare facilities industry includes all the companies that control facilities such as hospitals, clinics, nursing homes, laboratories, doctors' offices, and others.

The definition of managed care reported in the Cambridge Dictionary is: “a system in which medical costs are controlled by limiting the services that doctors and hospitals offer”³⁰, which basically stands for the healthcare insurance sector. According to Forbes, the five largest health insurance companies in U.S. in 2023 were Kaiser Permanente, Elevance Health (Anthem), Health Care Service Corporation (HCSC), UnitedHealth Group, and Centene Corporation³¹.

As of September 30th, 2021, within the S&P Global 1200, pharmaceuticals had the largest weight at the sub-industry level, representing approximately 38.3%, followed by health care equipment, 21.6%, and biotechnology, 12.4%. Managed healthcare accounted for only 7.8%, and health care facilities for 1.3%³².

Expenditures

The healthcare industry is characterised by high research and development expenses, representing in 2021 more than 12% of the total revenue in the sector³³. A study conducted

³⁰ Cambridge dictionary's definition.

³¹ Kissell C. (2023). *Largest Health Insurance Companies 2023*. Forbes, <https://www.forbes.com/advisor/health-insurance/largest-health-insurance-companies/> . Accessed in November 2023.

³² Orzano M., Granados H. H., Mintah J. (2021). *Global Sector Primer Series: Health Care*. S&P Global, <https://www.spglobal.com/spdji/en/education/article/global-sector-primer-series-health-care/> . Accessed in November 2023.

³³ Mikulic M. (2023). *Industry sectors - expenditure on research and development 2021*. Statista, <https://www.statista.com/statistics/270324/expenditure-on-research-and-development-by-industry-sectors/> Accessed in November 2023.

in 2003³⁴, estimated the average cost of creating a new drug to be around 1.2 billion USD (adjusted to 2019 prices)³⁵. However, more recent studies have shown that it has increased over the years and could actually be higher now, approximately 2.8 billion USD in 2016³⁶. These expenses must be carefully allocated to processes with a high probability of success, since they risk to become sunk costs if products are not approved by competent authorities in the end.

In addition to high costs, this industry is also known for the exceptionally long time required to develop a new drug, from initial development phases to the approval, which on average takes 12 to 15 years in U.S.³⁷. These long times are affected in U.S. by increasingly complex government regulations, as new drugs and devices need the approval of the Food and Drug Administration (FDA) before going on the market.

M&A

Mergers and acquisitions play a very important role in the healthcare industry, more than in almost any other sector. Companies seek to diversify and expand their portfolio by acquiring other firms and their drug pipeline³⁸.

³⁴ DiMasi J. A., Hansen R. W., Grabowski H. G. (2003). *The price of innovation: new estimates of drug development costs*. Journal of Health Economics, 22(2), 151-185.

³⁵ Simoens S., Huys I. (2021). *R&D Costs of New Medicines: A Landscape Analysis*. Frontiers in Medicine, 8, 760762.

³⁶ DiMasi J. A., Grabowski H. G., Hansen R. W. (2016). *Innovation in the pharmaceutical industry: New estimates of R&D costs*. Journal of Health Economics, 47, 20-33.

³⁷ Van Norman G. A. (2016). *Drugs, Devices, and the FDA: Part 1. An Overview of Approval Processes for Drugs*. JACC: Basic to Translational Science, 1(3), 170-179.

³⁸ It stands for all the drugs of a company that have not yet reached the market and that are still under development.

Since 2006 the volume of deals in this sector has followed a positive trend, and even during the COVID-19 pandemic the merger market did not suffer a slowdown in this industry, reaching 3771 global deals in 2020 compared to 3093 in 2019³⁹. The total value of the deals, instead, decreased from 586.41 billion USD in 2019 to 413.69 billion in 2020⁴⁰ but, excluding mega merger deals, it remained relatively in line with the previous years⁴¹. Then, 2021 marked the highest peak in terms of both volume and values, with 4526 deals and a total value of 620.27 billion USD.

All things considered, mergers and acquisitions performance continued to be solid in 2022 in global healthcare industry with a total of 3744 deals, still following a growing trend compared to previous years, excluding 2021, and a total value of 382.38 billion USD. As of the third quarter of 2023, the healthcare sector registered a decrease that reflects the global contraction of M&A volumes in all sectors, totalizing 2426 deals⁴² with a value of 284.55 billion USD⁴³.

³⁹ White & Case. *M&A activity by volume 2019 – 2022*. Sector: “Pharma, medical and biotech”. <https://mergers.whitecase.com/>. Accessed in November 2023.

⁴⁰ White & Case. *M&A activity by value 2019 – 2022*. Sector: “Pharma, medical and biotech”. <https://mergers.whitecase.com/>. Accessed in November 2023.

⁴¹ Mikulic M. (2023). *Pharmaceutical and biotech M&A deals – statistics & facts*. Statista, <https://www.statista.com/topics/8065/pharmaceutical-and-biotech-manda-activities/>. Accessed in November 2023.

⁴² White & Case. *M&A activity by volume 2019 – 2023 [YTD]*. Sector: “Pharma, medical and biotech”. <https://mergers.whitecase.com/>. Accessed in November 2023.

⁴³ White & Case. *M&A activity by value 2019 – 2023 [YTD]*. Sector: “Pharma, medical and biotech”. <https://mergers.whitecase.com/>. Accessed in November 2023.

Chapter 4

Dataset Analysis

In this chapter, after a brief overview of the database from which the data have been taken, it is illustrated the procedure used to select the sample considered to conduct the analysis.

Database

The considered data have been taken from the Refinitiv database, formerly Thomson Reuters, through the Eikon platform which allows to analyse financial information, providing access to industry data and insights. The Refinitiv database presents more than 1.2 million M&A deals since the 1970s, with a global geographical coverage⁴⁴. Over 1000 elements, quantitative and qualitative, are provided, giving a detailed insight on the transaction activity.

⁴⁴ LSEG Data & Analytics. *Mergers and Acquisitions services*. <https://www.lseg.com/en/data-analytics/investment-banking/mergers-and-acquisitions-services>

Dataset

The sample selection process involved several steps described below. The data were retrieved in October 3rd, 2023.

The Macro Industry selected to conduct the analysis is the Healthcare industry. In the database, this Macro Industry comprehends several Mid Industry sectors, as Pharmaceuticals, Other Healthcare, Hospitals, Healthcare Providers and Services, Healthcare Equipment and Supplies and Biotechnology. By analysing the whole Healthcare Industry, and not focusing on a specific sub-sector, a more wide and heterogeneous view is provided. Moreover, only the deals with the acquirer and target both belonging to this industry were considered, in this way the emphasis is completely on the healthcare sector.

As previously stated, the number of deals in this industry is very high, therefore some steps were taken to reduce the total amount of deals considered and make it easier to control and manipulate the sample.

The dataset was narrowed by considering only the deals with a value equal or greater than 10 million USD, and which were executed between January 1st, 2005, and July 31st, 2023. It was decided to consider the Date Effective, which indicates the completion of the transaction, rather than the Date Announced, when one or more of the parties involved publicly declare for the first time the intention to undertake the transaction, since it was considered more relevant for the type of analysis conducted.

The number of globally completed deals obtained by applying these constraints was 5929.

Study of the sample

First of all, a general analysis of the 5929 deals obtained has been done, with the aim to examine the dataset in more detail and to understand whether it was sufficiently heterogeneous and complete to conduct the analysis. Even if the focus of the study is on target companies, in this initial analysis also acquirers have been examined, for the reasons just mentioned.

Firstly, the sample distribution of the acquirer companies across different industries is reported in *Figure 4.1*. Around 40% of the acquiring firms belong to the Pharmaceuticals sub-industry, followed by Healthcare Equipment and Supplies, 26.5%, and Healthcare Providers & Services, 14.3%. Biotechnology and Hospitals industries together weight approximately 18.8% on the total, whereas only nine acquirers belong to the general category Other Healthcare.

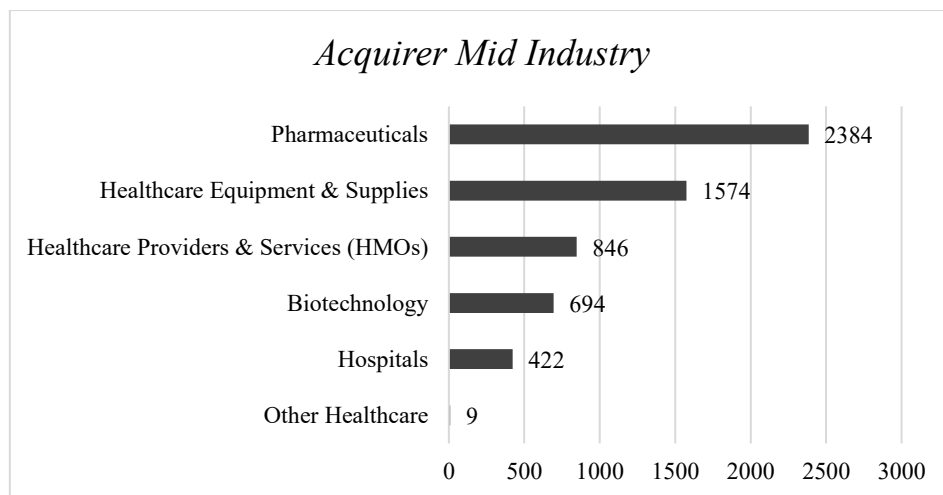


Figure 4.1: Sample distribution of acquirers across industries

With regards to the distribution of target companies reported in *Figure 4.2*, the two main sub-sectors are again Pharmaceuticals, 33.9%, and Healthcare Equipment and Supplies, 26.5%. The third place is taken by Biotechnology sector, almost 16.5%. The group of

companies that fall in Other Healthcare category can still be considered irrelevant, only five in this case.

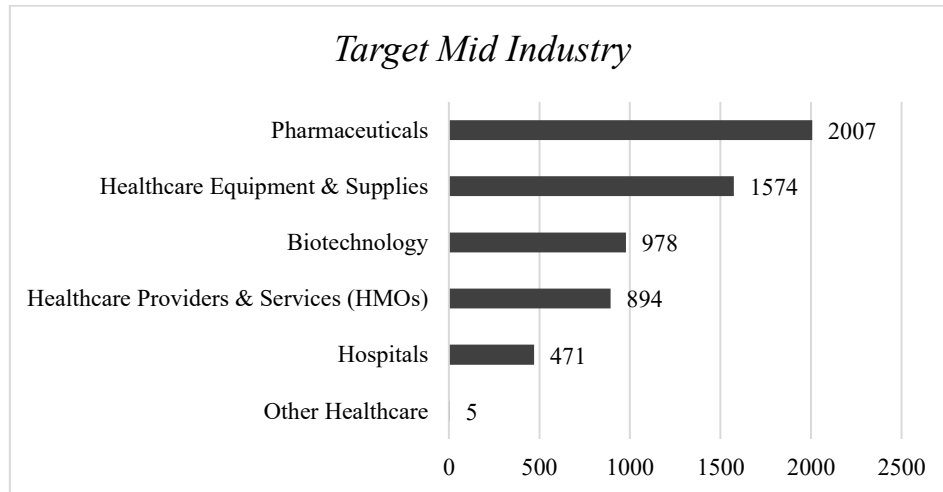


Figure 4.2: Sample distribution of targets across industries

These data, both those regarding the acquirers and those regarding the targets, are in line with the results, previously reported, of the various the sub-industries weights within the S&P Global 1200.

Then, the distribution of the deals per country of the acquirer and target companies has been analysed and it is reported in *Table 4.1* and in *Table 4.2* respectively. To have a clearer and more compact view, countries with less than 20 deals have been grouped in a single category named “Others”. In both cases, the large majority of the firms are located in the United States, with a percentage greater than 40%, followed by China, roughly 10.5%, and United Kingdom, around 5%. This does not surprise since these countries are the biggest players in the M&A field.

<i>Acquirer Nation</i>	<i>Number of Deals</i>
United States	2529
China (Mainland)	620
United Kingdom	326
Canada	293
Japan	264
Others (≤ 20 deals)	207
Australia	200
India	154
Germany	153
Switzerland	140
France	140
Sweden	115
South Korea	110
Brazil	105
Spain	82
Ireland	80
Italy	70
Hong Kong	57
Denmark	49
Netherlands	49
Singapore	44
Israel	37
Belgium	34
South Africa	24
New Zealand	24
Thailand	23
Total	5929

Table 4.1: Acquirer companies' distribution across countries

<i>Target Nation</i>	<i>Number of Deals</i>
United States	2786
China (Mainland)	628
Others (≤ 20 deals)	298
United Kingdom	274
Canada	231
Japan	191
Australia	179
Germany	169
India	153
France	126
Brazil	120
South Korea	103
Switzerland	95
Spain	70
Israel	67
Sweden	66
Netherlands	57
Italy	55
Belgium	36
Ireland	35
Hong Kong	31
New Zealand	31
Singapore	28
Denmark	26
Russia	26
Thailand	26
Taiwan	22
Total	5929

Table 4.2: Target companies' distribution across countries

Finally, the distribution of volume and values (in USD millions) of the deals across the years was analysed and it is reported in *Figure 4.3*.

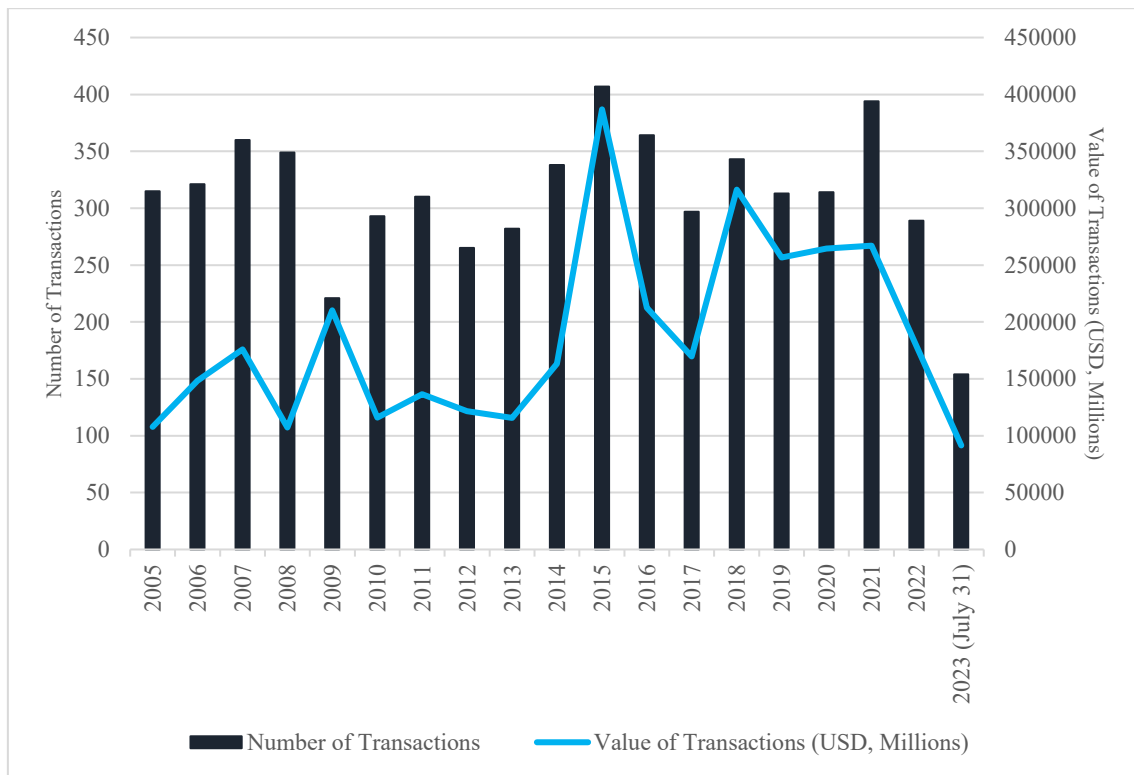


Figure 4.3: Volume and Values (in USD millions) of the deals across the years

The selected sample seems to represent quite well the totality of deals in the sector, even if several constraints have been applied. As a matter of fact, the sample appears to reflect the trends of M&A deals for this sector summarized in the previous chapter. As it can be seen in *Figure 4.3*, in 2020 the volume remained stable compared to the years before, whereas in the following year, 2021, it reached a peak and then decreased again in 2022.

Fifty deals

The values (in USD millions) of the 5929 deals obtained are distributed as reported in the table below.

<i>Deal Value</i>	
Minimum value	10.00
First Quartile	23.15
Second Quartile	62.81
Third Quartile	250.00
Maximum value	79376.83

Table 4.3: Distribution of the sample's deals values (USD millions)

After the study of the distribution of the sample's deals values, only those with a value between the first and the third quartile were considered. By excluding all the deals with a value lower the 23.15 million dollars USD or greater than 250 million dollars USD, the sample size dropped to 2966 transactions.

It has been arbitrarily decided to rank the deals according to their Deal Value, compensation paid by the acquiring company not considering fees and expenses, rather than taking the *Rank Value inc. Net Debt of Target* which “is calculated by subtracting the value of any liabilities assumed in a transaction from the transaction value and by adding the target's net debt”⁴⁵.

⁴⁵ Field definition in Refinitiv database.

Subsequently, the deals categorized as Repurchases or Self Tender and Recapitalization were excluded, because they were considered not relevant for the specific type of analysis here reported. As a result, the sample size decreased to 2834 deals.

Then, the study focused only on fifty of the 2834 deals that formed the sample. The final transactions were selected following several steps. First of all, they were ordered by deal value. Then for each deal, starting from those with higher value, it was checked if there were available data. If there were valid and complete data the deal was added to the final sample. If instead the target or the acquirer were lacking some data, the deal was excluded, and the next transaction examined. This procedure has been repeated until fifty deals were considered valid and added to the final sample.

To be more coherent, and to avoid possible undesired effects resulting from different closing dates, only deals with closing date on December 31st were considered.

Moreover, to conduct the regression analyses reported in the following chapter, only the transactions that involved different targets were considered in the selection of the fifty final deals. This was done because the focus is on targets. In this way possible data correlations, which could have affected the output of the analyses, were avoided.

Chapter 5

Methodology and Results

After recalling the scope of the work, this section reports the methodology used to carry out the analysis and the results obtained.

Scope of the work

Recalling that the scope of this work is to analyse whether companies in the years close to a merger or an acquisition take different investment decisions compared to previous years, the study will focus on research and development expenses made by target companies.

Methodology and Results

In order to analyse the dataset, the econometric tool used was the regression paradigm.

Regression analysis is used in statistics to model the relationship between two or more variables. The simplest regression model describes the linear relationship between only two variables, a dependent variable (y) and an independent variable (x). In case of more than one independent variable, the regression is multiple. The model can also be generalized to non-linear relationships.

Linear regression tries to describe the relationship between the variables using a straight line that fits the data. The attempt is to successfully use the information about the independent variables to predict the value of the dependent one. This is done by estimating the slope parameters of the independent variables that form the regression line. The coefficients estimated indicate the change of the dependent variable resulting from a change in the independent variables.

The multiple linear regression model is reported below.

$$Y = \beta_0 + \beta_1x_1 + \dots + \beta_nx_n + \varepsilon$$

- Y indicates the dependent or predicted variable, also called *regressand*.
- x_1, \dots, x_n are the independent variables, or *regressors*, and their betas are the coefficients that correspond to the effect on Y of a unit change in the respective x, all else held constant.
- β_0 is the intercept, the value that the dependent variable assumes when all the regressors are equal to 0.
- ε stands for the regression error.

Regression model

The analysis focuses on the R&D expenses of the three years preceding each deal, since years too far away in time from the completion of the transaction were considered less relevant and barely influenced by the transaction itself.

The items of the financial statements that have been analysed are those that have an impact on R&D investments. After a broader analysis, only the ones that turned out to be relevant were included in the regression model.

Firstly, an aggregated analysis of the three years was carried out to identify which variables could more likely have a direct impact on R&D.

To evaluate the years together, for each of the variables taken into consideration, a weighted mean of the values was calculated. Arbitrarily, the year preceding the deal was given a weight of 1. The values corresponding to two and three years before the transaction were weighted 0.9 and 0.8 respectively. This was done to give more importance to the decisions taken in the most recent years, which are likely to be more affected by the upcoming deal.

The formula is reported below.

$$\text{Weighted Mean} = \frac{1 * 1 \text{ year before} + 0.9 * 2 \text{ years before} + 0.8 * 3 \text{ years before}}{2.7}$$

Some of the variables taken into account were Net Margin, Debt/Equity and Net Intangibles but for each of them too many companies did not report complete data. For this reason, they were discarded from the analysis, otherwise the regression wouldn't have been carried out on enough data, and the result would not have been significant. Therefore, the first model used was the one reported below.

$$R\&D = \beta_0 + \beta_1 \text{Operating Income} + \beta_2 \text{Total Assets} + \beta_3 \text{Free Cash Flow} + \varepsilon$$

Then Free Cash Flow was replaced with Cash & Equivalent (or Cash, as it will be explained later), because the Free Cash Flow regressor turned out to be not significant. Eventually, the Operating Income variable was eliminated and then replaced by Revenue. This was done because R&D expense is an operating cost, thus reducing the operating income value, which therefore lacks the independence requirement necessary to carry out this type of analysis.

After this initial examination, the study focused on each year singularly since the scope of the work is to see if companies take different investment decisions throughout those years.

Hence, the model initially adopted to conduct the final analysis was the one reported below.

$$R\&D = \beta_0 + \beta_1 \text{Revenue} + \beta_2 \text{Total Assets} + \beta_3 \text{Cash} + \varepsilon$$

The results of these analyses are reported in the appendices. Firstly, in appendix A the results of the regression analyses carried out taking from the same year the values of the independent variables and of the dependent one. The number of observations for each regression is lower than fifty, because some companies did not report data for cash or revenue in one or more years, and therefore those observations were eliminated. Then the same regression model was used to carry out the analyses on different years, taking the independent variables of the year before the dependent one. This was done because there was the risk that the variables influenced each other, leading to not accurate results. The outputs obtained from these regression analyses are reported in appendix B.

As it can be seen in the tables, in both cases the coefficients of revenue have a negative sign, not in line with expectations, since usually the more revenue a firm has the more it is expected to invest in R&D. This unexpected behaviour might be due to the fact that the closer the deal gets, the more it is probable that the firm knows that it will be acquired, therefore it might have less necessity to spend on R&D and to invest to attract acquirers. Moreover, research and development expenses may have an impact on revenue. For example, they might involve the development of a product which leads to new revenues, especially in this type of industry. For these reasons, eventually, this regressor was excluded from the analysis. Revenue is a very tricky variable and there was the risk that it affected the results in a wrong way.

Thus, the final variables taken into consideration are the following.

- **Total Assets.** It indicates the totality of the economic resources owned by a company. Total assets are an important business valuation tool and are analysed by investors when taking their decisions.

- **Cash & Equivalents.** They represent all the assets of a company that are cash or that can be converted into cash quickly, securities with a maturity equal or lower than 90 days. Three of the fifty companies taken into consideration did not exhibit the entry Cash & Equivalents on their balance sheet, for these firms the Cash item was taken. Instead, those targets that presented the record Cash & Equivalents but with invalid data in one or more of the three years examined, were simply removed from the regression analysis of that year. For simplicity, from now on this variable will be referred to as Cash.

The regression model thus obtained is reported below.

$$\text{Research \& Development} = \beta_0 + \beta_1 \text{Total Assets} + \beta_2 \text{Cash} + \varepsilon$$

β_1 indicates the increment in research and development expense for a unit increase in total assets, all else held constant, and β_2 is the increment for a unit increase in cash, all else held constant.

It is important to highlight that the independent variables used in the final model are relative to one year before the one of the R&D expenses taken into consideration. For example, if the R&D expense is relative to the year preceding the deal the values of the regressors are relative to two years before the deal. This model was chosen to avoid the risk of reverse causality. Taking all the data from the same year could lead to results influenced by the fact that not only the independent variables affect the R&D value, but also the opposite.

Third year before the transaction

The three years before the transaction were taken singularly and analysed separately to see how the decisions of target companies relative to R&D expenditures change throughout that period.

Recalling that the independent variables are relative to the year before the one of the R&D expenses considered, first the R&D values analysed were only those relative to the third year before the transaction, and therefore the independent variables relative to the fourth one. As previously explained, the cash values were selected for the targets that did not have the Cash & Equivalents record, while the companies reporting non valid data in that section were eliminated. In this case four targets were removed, thus reducing the number of observations to forty-six. The null hypothesis is that all the betas of the model, excluding the intercept, are zero. The results obtained are reported in the tables below.

<i>Regression Statistics</i>	
R multiple	0.6976
R Square	0.4866
Adjusted R Square	0.4627
Standard Error	21.8339
Observations	46

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	19429.3738	9714.6869	20.3782	5.9524E-07
Residual	43	20498.9830	476.7205		
Total	45	39928.3569			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	13.5937	4.0817	3.3304	0.0018	5.3622	21.8252
Total Assets	-0.0364	0.0420	-0.8671	0.3907	-0.1210	0.0482
Cash	0.5086	0.1076	4.7260	2.4702E-05	0.2916	0.7257

Table 5.1: Output of the third year before the deal's regression analysis

The first element to examine is the R-squared, coefficient of determination, which measures the fraction of variance of the dependent variable explained by the independent variables. It indicates how well the data are described by the regression; it is a measure

of the goodness of fit of the model. The value of R-squared range between 0 to 1. Zero means that the model explains absolutely nothing about the relationship between the independent variables and the dependent one, whereas 1 indicates that the relationship is completely explained by the model. Thus, the nearer R-squared is to 1 the more accurate the regression model is.

However, R-squared tends to be an optimistic indicator so it is always better to examine the adjusted R-squared which corrects it. Adjusted R-squared accounts for the regressors that do not effectively improve the regression model and therefore are not significant. While the value of R-squared never decreases when a regressor is added to the model, adjusted R-squared might. Thus if, by adding more independent variables, the adjusted R-squared lowers, the added variables are not improving the model.

In the case analysed, the values of the R-squared and adjusted R-squared are around 0.49 and 0.46. This model can be therefore considered acceptable so far, given that the independent variables taken into consideration are only two. However, there are also other elements that must be carefully examined.

The second element that should be evaluated is the standard error which is also an indicator of the model goodness of fit. It is a measure of the average distance of the observed value from the regression line, thus the lower it is the more accurate the regression model is. If by changing the regression model the R-squared increases and the standard error decreases, the measure of fit is improved. In this case also the standard error can be considered acceptable.

A further aspect that should be examined is the Analysis of Variance (ANOVA). An important component of this table is the F-value which is measured as the ratio between the mean sum of squares of the regression and the mean sum of squares of the residual. The F-value should then be compared to the critical value in the F distribution table. If it is higher, the null hypothesis should be rejected. In this case the critical value is around 3.2 and the F-value is over 20.

Moreover, if the significance F is lower or equal than the significance level, 0.05, the null hypothesis can be rejected. In this case the value obtained is significantly lower than 0.05, so it is rejected.

Considering the coefficients of the independent variables, it can be seen that total assets have a negative impact on R&D expenses (negative sign of the coefficient) which means that for every additional dollar that the company has in total assets, the R&D expense decreases approximately by 0.0364 dollars. Cash has instead a positive effect on the dependent variable, increasing the total R&D expense by 0.5086 dollars for every additional dollar. The sign of cash is pretty in line with expectations, since generally the more cash a firm has, the more it is expected to invest in R&D. Instead, the sign of total assets is surprisingly negative, but only slightly.

Finally, for what concerns the statistics, the total assets variable is not significant since its t Stat is lower than 1.96 (critical value at 5% level for a two-tailed test) in absolute value and its P-value is considerably higher than 0.05. This means that in the third year before a merger or an acquisition, the amount of R&D expenses is not influenced by the value of total assets at the end of the previous accounting period. The cash variable, on the other hand, is significant.

Second year before the transaction

Then, the same study was done considering only the R&D expense of the second year before the merger. For the reason explained before, the independent variables considered are in this case relative to three years before the transaction.

The output obtained by this regression analysis is reported below.

<i>Regression Statistics</i>	
Multiple R	0.6393
R Square	0.4087
Adjusted R Square	0.3818
Standard Error	22.4558
Observations	47

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	15337.0330	7668.5165	15.2074	9.5378E-06
Residual	44	22187.4909	504.2612		
Total	46	37524.5239			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	6.4688	4.8080	1.3454	0.1854	-3.2212	16.1587
Total Assets	0.0755	0.0289	2.6091	0.0124	0.0172	0.1337
Cash	0.3089	0.0890	3.4726	0.0012	0.1296	0.4882

Table 5.2: Output of the second year before the deal's regression analysis

Three of the fifty considered targets had invalid data of Cash & Equivalents in the year examined and therefore they were excluded from the regression analysis, which was thus conducted on forty-seven observations.

The values of adjusted R-squared and Significance F obtained are worse than before, however they can be still considered acceptable.

The cash variable behaves in the same way as before, with a positive impact on R&D expenses even if lower (now around 0.3 compared to 0.5 before). The effect of total assets becomes positive, even if only slightly, more in line with expectations.

As it can be seen, the total assets variable becomes significant in this year whereas cash continues to be. This means that now the value of total assets has an impact on the amount of R&D expenses. Therefore, the R&D expenses relative to two years before the deal are influenced by total assets and cash values of the year before.

First year before the transaction

Finally, the analysis of the R&D expense relative to the year before the transaction was carried out and the results are reported in the tables below.

<i>Regression Statistics</i>	
R multiple	0.7470
R Square	0.5580
Adjusted R Square	0.5379
Standard Error	28.5906
Observations	47

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	45400.0783	22700.0392	27.7703	1.5847E-08
Residual	44	35966.5681	817.4220		
Total	46	81366.6464			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-3.0137	6.0377	-0.4991	0.6202	-15.1819	9.1545
Total Assets	0.3071	0.0481	6.3899	9.0079E-08	0.2103	0.4040
Cash	-0.1140	0.0807	-1.4137	0.1645	-0.2766	0.0485

Table 5.3: Output of the first year before the deal's regression analysis

Following the same logic as in the other two cases, the independent variables here considered are relative to the second year before the deal.

Moreover, the number of observations taken into consideration is the same as before, forty-seven, since only three targets had to be excluded.

Total assets variable still has a positive impact on R&D expenses, while the cash variable now negatively influences it. It is important to notice that the coefficient of total assets has more than tripled. For every additional dollar in total assets the expense in research and development now increases by 0.3071 dollars.

The relevant aspect in the year under examination is that the cash variable has become not significant since it has a P-value greater than 0.05. On the other hand, the other independent variable is significant. This means that in the last year before the merger, the amount of R&D expenses does not depend on the cash value in the balance sheet at the end of the previous year.

T-test

To validate the results, a t-test was conducted on the coefficients obtained from the three regression analyses. The null hypothesis is that the coefficients of the same independent variable on different years are equal, against the alternative hypothesis that their difference is not zero and therefore that it is statistically significant.

To find the T value, which follows a t Student distribution, the formula used was the following.

$$T = \frac{x_1 - x_2}{\sqrt{S^2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

The value of S^2 is obtained from the formula below.

$$S^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

The values of s_1 and s_2 are calculated using the following formulae.

$$s_1 = se_1 \sqrt{n_1}$$

$$s_2 = se_2 \sqrt{n_2}$$

The analysis was conducted on each independent variable, taking as x_1 and x_2 the coefficients of different years. The results obtained are reported in the following table. Considering for example total assets, x_1 is the coefficient of the first regression analysis, the one with R&D of the third year before the deal, and se_1 is its standard error. Instead x_2 is the coefficient resulted from the second regression, the one with R&D of the second year before the merger, and se_2 is its standard error.

For each test, if the resulting T is lower than 1.96 in absolute value, the null hypothesis cannot be rejected and therefore it is not demonstrated that the difference between the two values is statistically significant at 5% significance level.

	Year 3-2	Year 2-1
Total Assets	2.2029	4.1300
Cash	-1.4330	-3.5220

Table 5.4: T values resulting from the statistical test

As it can be seen, the resulting T values for cash show that, even if the difference between the second and third year coefficients is not statistically significant, the difference between the second and first year coefficients is. This validates the result previously obtained that there is a change in target companies' behaviour when investing in R&D so that the expense in the last year before a transaction does not depend on the amount of

cash value at the end of the previous accounting period. For what concerns total assets, both the differences are statistically significant. This confirms the result found in precedence that R&D expense changes from not being influenced by total assets in the third year before the transaction, to be so in the second and first years before the transaction, when the regressor becomes significant.

Results

Considering the results together, there is evidence of how the R&D investment choices of target companies in the healthcare sector change before a merger. This study shows that there is a relation between the values of total assets and cash and the amount of research and development expenses.

In the second year before the transaction, the value of total assets influences target companies' R&D investment decisions positively, with a coefficient of 0.0755, which has more than tripled in the following year. This means that in the last year before the merger the total amount spent on R&D increases by 0.3071 dollars for every additional dollar in total assets at the end of the previous accounting period.

The cash variable instead behaves in a different way. It is significant in the first two regression analyses and then it becomes not significant in the last year before the deal. Economically speaking, before the last year, the amount of dollars spent on R&D by the target companies analysed is influenced by the total amount of cash in the balance sheet at the end of the previous year. For every additional dollar in cash, firms spend on R&D on average an extra 0.5086 dollars in the third year before a merger and 0.3089 dollars in the second one. In the last year instead, there is no more evidence of this relationship.

This is interesting because it shows that the target companies analysed behave differently in the years preceding the deal, looking at different elements of the financial statements

when they have to decide the level of R&D investments. Even if they must be interpreted with caution since the number of deals considered are only fifty, these findings are worthy of note.

The results here highlighted differ, under some aspects, from the findings obtained in previous studies. For example, G. M. Phillips and A. Zhdanov's work (2013)⁴⁶ states that the bigger a company is the less it needs to invest in R&D. In the results obtained in this study, the coefficient of total assets is positive in the last two years before the transaction, and it increases the closer the deal gets. This means that the more total assets a target company has, and so it is considered big, the more it invests in R&D, which is the opposite of what G. M. Phillips and A. Zhdanov stated.

⁴⁶ Phillips G. M., Zhdanov A. (2013). *R&D and the Incentives from Merger and Acquisition Activity*. *Review of Financial Studies*, 26(1), 34-78.

Chapter 6

Conclusions

The aim of this work was to investigate if companies, particularly targets, take different investment decisions in the years preceding a transaction.

After a broad introduction to the concept of M&A and the healthcare sector, to which the studied sample belongs, the statistical analyses on the three years considered were carried out.

Even if the results obtained can be inaccurate because the analysis was carried out on a relatively narrow sample, due to limited time and the tools used, they are worthy of note. However, there are some possible further analyses that could be done in the future to verify whether these results are valid.

Firstly, despite many other variables had already been examined before deciding the final regression model, some more could be considered in the future. For example, the Debt on Equity value, not included in this model for lack of data, which may affect the R&D level negatively since the more a company is indebted the less it probably invests in innovation, or the Return on Assets value that could instead have a positive effect on research and development expenditures.

Then, the same study could be carried out on a bigger sample, leading to more accurate and solid results.

Appendix A

<i>Regression Statistics</i>	
R multiple	0.7817
R Square	0.6110
Adjusted R Square	0.5811
Standard Error	19.6116
Observations	43

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	23558.3613	7852.7871	20.4172	4.0716E-08
Residual	39	15000.0051	384.6155		
Total	42	38558.3664			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	3.5413	4.3769	0.8091	0.4234	-5.3117	12.3944
Revenue	-0.3046	0.0712	-4.2794	0.0001	-0.4485	-0.1606
Total Assets	0.2666	0.0543	4.9070	1.6791E-05	0.1567	0.3765
Cash	0.1473	0.0974	1.5123	0.1385	-0.0497	0.3442

Table A.1: Output of the third year before the deal's regression analysis

Appendix A

<i>Regression Statistics</i>	
R multiple	0.7213
R Square	0.5203
Adjusted R Square	0.4852
Standard Error	20.2867
Observations	45

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	18304.6900	6101.5633	14.8258	1.1027E-06
Residual	41	16873.6055	411.5514		
Total	44	35178.2955			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	4.9554	4.4146	1.1225	0.2682	-3.9599	13.8708
Revenue	-0.1223	0.0588	-2.0799	0.0438	-0.2411	-0.0036
Total Assets	0.2203	0.0385	5.7198	1.0827E-06	0.1425	0.2980
Cash	-0.0380	0.0598	-0.6350	0.5290	-0.1588	0.0828

Table A.2: Output of the second year before the deal's regression analysis

Appendix A

<i>Regression Statistics</i>	
R multiple	0.9538
R Square	0.9098
Adjusted R Square	0.9037
Standard Error	12.5717
Observations	48

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	70159.8254	23386.6085	147.9726	5.2930E-23
Residual	44	6954.0616	158.0469		
Total	47	77113.8870			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	7.3542	2.2284	3.3002	0.0019	2.8632	11.8452
Revenue	-0.2621	0.0267	-9.8147	1.1859E-12	-0.3159	-0.2082
Total Assets	0.1726	0.0097	17.7447	1.1274E-21	0.1530	0.1922
Cash	0.2032	0.0297	6.8339	2.0033E-08	0.1433	0.2631

Table A.3: Output of the first year before the deal's regression analysis

Appendix B

<i>Regression Statistics</i>	
R multiple	0.9196
R Square	0.8456
Adjusted R Square	0.8324
Standard Error	11.3119
Observations	39

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	24530.1375	8176.7125	63.9009	2.8153E-14
Residual	35	4478.5778	127.9594		
Total	38	29008.7154			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	10.8882	2.2652	4.8068	2.8719E-05	6.2896	15.4867
Revenue	-0.2735	0.0538	-5.0800	1.2599E-05	-0.3828	-0.1642
Total Assets	0.0774	0.0455	1.7023	0.0976	-0.0149	0.1698
Cash	0.4828	0.0702	6.8778	5.4956E-08	0.3403	0.6253

Table B.1: Output of the third year before the deal's regression analysis

Appendix B

<i>Regression Statistics</i>	
R multiple	0.8229
R Square	0.6772
Adjusted R Square	0.6524
Standard Error	16.7585
Observations	43

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	22981.3316	7660.4439	27.2761	1.1207E-09
Residual	39	10953.0769	280.8481		
Total	42	33934.4085			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	5.1954	3.7401	1.3891	0.1727	-2.3697	12.7605
Revenue	-0.3621	0.0608	-5.9530	6.0197E-07	-0.4851	-0.2390
Total Assets	0.3152	0.0464	6.7885	4.1881E-08	0.2213	0.4091
Cash	0.0176	0.0832	0.2113	0.8337	-0.1507	0.1859

Table B.2: Output of the second year before the deal's regression analysis

Appendix B

<i>Regression Statistics</i>	
R multiple	0.7564
R Square	0.5721
Adjusted R Square	0.5408
Standard Error	28.2037
Observations	45

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	43609.3099	14536.4366	18.2746	1.1070E-07
Residual	41	32613.3065	795.4465		
Total	44	76222.6164			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-2.2159	6.1373	-0.3610	0.7199	-14.6105	10.1787
Revenue	-0.1373	0.0818	-1.6791	0.1007	-0.3024	0.0278
Total Assets	0.3503	0.0535	6.5428	7.3170E-08	0.2422	0.4584
Cash	-0.1290	0.0832	-1.5517	0.1284	-0.2970	0.0389

Table B.3: Output of the first year before the deal's regression analysis

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