POLITECNICO DI TORINO

MASTER's Degree in Engineering and Management

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Analysis of the relationship between R&D Investment and Merger and Acquisition Transactions

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Abstract

The thesis has the objective of explore the relationship between innovation and corporate takeovers, examining how strategic acquisitions impact innovation within the acquiror and target firms. To introduce the study, in the first section is performed an analysis of what M&A are highlighting the main drivers of corporate takeovers and what are the strategic reasons that influence management behaviour. In the second section is performed an analysis of how and why firms innovate, specifically in the high-tech market, a review of the literature is presented to support the study. The third section contains the effective work, some of the literature's suggestions are tested, specifically the link between source of innovation (namely R&D investment) and the market of corporate takeover. To deliver what described before, an empirical analysis on a sample of M&A deals is presented to refuse or confirm the hypothesis presented. The empirical analysis is made of multiple-factor regression, also known as multiple regression analysis, is a statistical technique used to analyse the relationship between a dependent variable and two or more independent variables. It is used to predict the behaviour of the dependent factor through a linear equation made of the independent factors and their coefficient. In the last section the results are commented and the conclusion of the analysis is presented. However, the analysis results are not perfect because of the multitude of factors that could be take in consideration, more other models and methods can be introduced in the analysis to improve it.

Chapter 1

Introduction

The thesis aims to explore the relationship between sources of innovation and Merge and Acquisitions (M&A). The choice to deal with this topic stems from a personal passion for technology and in general for when in certain sectors, such as high tech which will be analyzed in this study, paradigms are broken down at the release of a new technology, for M&A on the other hand, the interest stems from the studies faced during my university career which allowed me to delve into certain dynamics witnessed in the world of high tech. Some exemples are Apple, when launching the first IPhone changed the whole cellphone industry or Facebook (META today) that acquired Oculus to have access to the VR technology for their Metaverse project that is still under development. There are several case of successful deals that led to a great integration of the target new technology in the acquiror company like Disney and Pixar or Amazon and Kindle, those famous cases are great example of the potential benefits that obtaining a new technology would bring both to the target, because the funds made available would return thanks to the acquisition, both to the acquiror that would obtain innovative technology without spending many resources in large projects. This report is interesting in more ways than one, innovation in industries has always been a crucial issue starting with the more classic make or buy decision. This type of analysis is interesting in that the correlation between innovation and the public firm market is of interest both in the study of strategic choices and how certain industries change as a result of new technologies that change their paradigms. This paper aims to assess when the decision to make an asset that is rare and can provide a competitive advantage becomes convient for a firm, which is defined as a target in the M&A literature. Thus, the main focus falls on R&D expenditures and when the decision for the target firm also becomes optimal depending on the Acquiror firm's innovation interests. The goal is to research the correlation between R&D activities and activity in the acquisition market, the complementarity of assets, and in general how M&A dimanics can influence the decisions of the individual firm. As a starting

point, a set of research regarding the topic was chosen where R&D was analyzed from a purely decision-making point of view and with a view to greater market desirability, from the study of these relationships, literature was sought regarding the correlation between innovation, the investments made to obtain it, and how they impact the decisions of larger players in decisions to obtain it internally or externally. The thesis is therefore divided into several sections, the first of which aims to introduce the reader to the workings and basic logic of the M&A world and what are the main drivers that lead to the success or failure of a deal, through both an analysis of the more classic literature and more recent studies by researcher or industry observers. In the second, we look at what are the main theories that analyze innovation from a strategic point of view for a company and when it actually brings added value to the company, here we research in the literature what distinguishes a good project from an invalid one and how this is configured as a competitive advantage for those who obtain this advantage. the last two sections deal with the actual research work, the first consisting of a brief description of the database used and how the data collection and subsequent creation of the dataset was done. The second is the description of the actual model where the hypotheses obtained from the literature study were tested. There are 6 models in total, with the first two analyzing the relationships between R&D, Intangible assets and the selected independent variables. The last 4 models, also called models on ratios, deepen the relationships identified in the first two models by going, however, to analyze the relationship between R&D expenditures and total expenditures, and the relationship between intangible assets and total assets. The work carried out is based on the statistical method of multiple linear regression, which makes it possible to study not only the correlation between a dependent variable and one or more independent variables, but also to go on to make predictions based on the behavior of the variables over a given period of time; this methodology is used in several areas including finance. Conclusions can be found at the end of the paper where the results obtained from the regressions are described and interpreted.

Chapter 2

M&A, an overview

In this first chapter is presented an overview of what M&A are and how they work to introduce the analysis explained in the next chapters. Mergers and Acquisitions (M&A) are classified as extraordinary financial transactions which determine a shift in the ownership of, at least, two companies. The main focus of this work is the strategic framework that each company pursues to reach several goals. It is important to define some terms[1]:

- *Takeover*: Is a generic term for Mergers and Acquisitions.
- *Marger*: 2 or more firms are combined. Both boards and general shareholders assembly must approve the deal.
- *Acquisitions*: Acquirer (also called buyer or bidder) buys target (seller). It is not always so easy to distinguish an acquisition from a merge.
- *Friendly and Hostile takeovers*: the distinction will be explained in the next section. The main differences are under the legal aspect and management behaviour.

This kind of operation are a form of external growth, an alternative to internal growth. They constitute a large market ($ Trillions) and have a direct impact on many actors:

- *Shareholders*: Shareholders value creation/destruction.
- *Debtholders*: Changes in default probabilities, a debtholder can see either an increase of get back money landed or to lose priority against major debt used to finance the operation.
- *Employees*: Restructuring (cost cutting), mobility, expansion have an impact on the workforce.

- *Customers*: Change in market power or product configuration, change in policies for services and how they will be integrated in the new entity.
- *Other stakeholders*: suppliers, communities have interest in how a company strategy is configurated.

2.1 Type of Deals

Depending on the target, it is possible to distinguish between acquisition of company shares (share deal) or acquisition of business units or, again, of individual categories of assets (asset deal).
From a technical point of view, the most commonly used ways of carrying out acquisition transactions can be distinguished into:

- The acquisition tout court or acquisition proper.
- Leverage buy out (LBO).
- Tender offer (OPA).

The acquisition tout court or acquisition proper: is that type of transaction by which the ownership of a controlling shareholding (or a business unit) is transferred from a selling party (target company) to another buying party (or bidder company). Such an acquisition often takes place outside the stock market and cash payment prevails. Acquisitions do not necessarily have to be paid for in cash, but, payment can also be made through the sale of a corporate stake in the acquiring firm.
Leverage buy out (LBO)[2]: consists of an acquisition made through debt. This procedure takes place with a series of financial transactions aimed at acquiring a company. This acquisition can take several forms, but in this discussion we will analyse, for simplicity's sake, its most classic form. The purchasers (often the directors themselves) establish a special purpose vehicle (new company) with modest share capital, which must obtain a loan (from a bank), used in the purchase of shares in the target company. After gaining control of the latter, a merger by incorporation between the two (or more) companies is resolved, and the indebtedness of the newco is also transferred to the acquired company, which, will have to bear it, and at the same time manage to derive tax benefits from it as well. For this purpose, the required financing will be repaid from the future profits of the merged target company and/or through the sale of part of its assets[3].
A takeover bid (OPA) is a transaction to acquire controlling interests that is carried out on the stock exchange. The takeover bid is a mechanism regulated the law (artt. 91 – 112 del Testo Unico delle disposizioni in materia di intermediazione finanziaria (TUF), D.lgs. 24 febbraio 1998, n.58 in Italy) and by some rules of Consob (Italy) or SEC (USA).
Another distinction is between friendly and hostile takeovers, the key distinction is the level of cooperation and willingness of the target company's management. Those aspects are summarized as:
Friendly Takeover:

- Willing Cooperation: In a friendly takeover, the acquiring company and the

target company's management are willing to work together to facilitate the acquisition.

- Negotiation and Agreement: The negotiations are conducted with the consent of the target company's management. Both parties engage in discussions and reach an agreement that is often recommended by the target company's board of directors to its shareholders.
- Support from Target Management: The target company's management is generally supportive of the acquisition, and they may actively endorse it to shareholders.

Hostile Takeover:

- *Unwilling Cooperation*: In a hostile takeover, the acquiring company pursues the acquisition without the consent or cooperation of the target company's management.
- *Confrontational Negotiations*: Negotiations in a hostile takeover can be confrontational, with the target company's management resisting the acquisition. The acquiring company may face opposition and challenges from the target company's board of directors.
- *Resistance from Target Management*: The target company's management is often opposed to the acquisition and may employ defensive measures to resist the takeover, such as implementing poison pills or seeking alternative buyers.

2.2 Theoretical Models

Part of the literature understands acquisitions as those instruments aimed at achieving a growth objective from a purely economic point of view for the company[4].
The term "business acquisitions" refers to those transactions by which control of a company is obtained, and therefore includes purchases, business contributions and mergers.
The terminology "Mergers and Acquisitions" is used to refer to all those extraordinary transactions of mergers and acquisitions from the organizational and substantive aspect without regard to the legal form under which they take place[4].
M&A transactions have been widespread both nationally and internationally because of the speed with which they enable competitive advantages to be gained from expanding the buyer's market share and also know-how.
The increasing popularity of such transactions has allowed them to be a central topic of economic debate particularly in the context of defining the optimal size of a firm. Because the factors involved in these transactions are multiple and complex, there has been a succession of analyses that do not always agree on the effects they have on multiple business actors.
There are several schools of thought in the literature that can be distinguished into studies with an economic approach and studies with a business approach. Within economic studies, one can distinguish Industrial organization and Financial economics, of which the former investigates the consequences of M&A on the economic system and the latter focuses on shareholders and the impacts on them. Specifically, Industrial Organization is based on the structure-conduct-performance archetype according to which the structure of the firm influences its behaviour and thus, consequently, its performance. In this way, mergers and acquisitions become a means by which to influence market structures.
These studies draw on F. M. Sherer (1980)[5] who points out how and to what extent M&As foster market concentrations. The objectives pursued through them are numerous, but from an empirical point of view, their actual influence on performance and consequences for the economy cannot be demonstrated. Financial Economics also notes the effects of M&As from a financial perspective. This field of studies uses the technique of event studies, in which deviations between the actual and expected returns of shares of listed companies involved in M&A transactions and estimated by classical financial methods[6] are to be detected. In the field of business studies, Strategic Management and Organizational Behaviour can be further distinguished. Strategic Management studies are divided into current variance approach and current process approach, which are complementary to each other. The variance approach aims to investigate the links between the explanatory and adaptive variables of a phenomenon, while the latter focuses on the mechanisms and processes that create a phenomenon[7]. The process approach originates from

the studies of Jemison and Sitkin, who highlight the process of acquisition and the processual traps that can influence the success or failure of the operation. The authors emphasize how the performance effects of the acquisition are affected by the micro processes that create the entire M&A process. According to several authors, the acquisition process consists of distinct stages, such as:

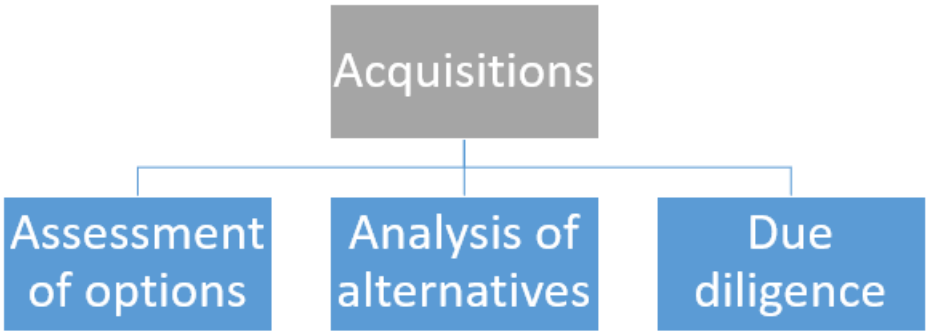

Figure 2.1: Stage of the deal – Strategic Management

The Organizational Behaviour strand, studies how acquisitions lead to consequences at both the individual and organizational levels based on the concept that it is the quality of the acquisition process that determines the positive outcome of the transaction. These researchers have also highlighted the negative effects of acquisitive transactions, in the following areas:

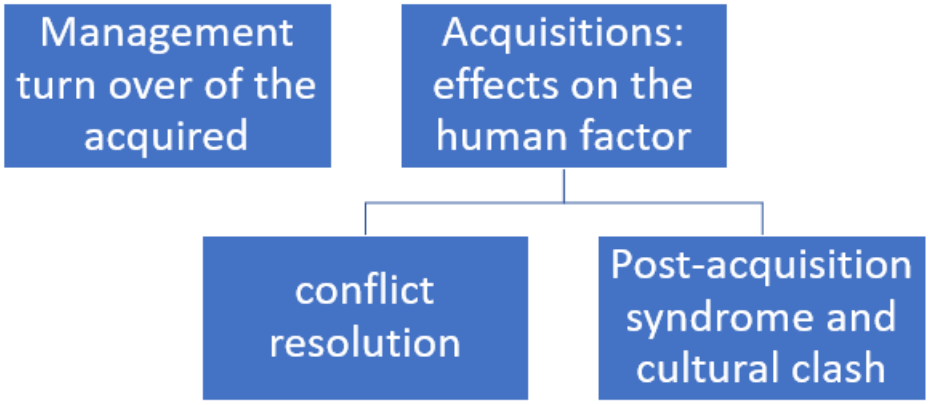

Figure 2.2: Organizational behavior areas

2.3 Benefits from merging activity

Mergers can be classified into horizontal and vertical with reference to the line of business involved. Horizontal are said to be those mergers in which two firms in the same line of business merge; vertical, on the other hand, are said to be those if they include organizations operating at different levels of the same production chain. The literature considers factual the overcoming of the conception of the merger as an operation that involves the extinction of the existing merged entities in the new legal entity and the universal succession of the constituting company, since it has come to the conception that the merger realizes a modification of the existing constituent acts with continuity in the performance of the productive activity. With regard to the technical-economic aspect, studies identify the technical-productive business-economic motivations in the division of mergers as interesting. Using this parameter, mergers can be classified into mergers: by union, by incorporation and reverse. Of these, merger by incorporation is the one that has gained the most popularity because of its lower costs and wider simplicity of practical and procedural implementation. The motivations behind M&A transactions have been analyzed, and the literature lists multiple[4]:

- Inefficiencies eliminations.
- Economies of scale and integration.
- Combination of complementary resources.
- Diversification.
- Use of tax benefits.
- Use of excess liquidity.
- Decrease in the cost of access to finance.

Interestingly, in relation to the benefits outlined, it can generally be said that an extraordinary transaction produces a benefit because the value of the firm as a result of the transaction is greater than the sum of the values of the firms involved. This is perfectly in line with the idea that extraordinary transactions in the framework of the appropriate tools to create value, effectively respond to the needs of flexibility, adaptive capacity, increased innovation, search for strategic downsizing to enable the enterprise to compete successfully in its market of operation.
A key practice is to minimize risk. This practice implies the careful evaluation by management of the potential companies involved in the acquisition or merger transaction, according to a dual perspective: from a strategic point of view and from an economic-financial point of view. In terms of strategic vision, companies

that share production resources, technical and technological know-how are to be preferred, consequently, the pooling of skills derived from the activity carried out previously that will allow to exploit the resulting synergies. As a first step, it is important to carry out an assessment of enterprises belonging to the same commodity sector, eliminate those that do not meet the criteria sought, and identify the best one to recognize the sources of connection.
Common competencies are the key to act on to develop new actions through diversification, to enter new markets with profitable future development rates. At the end of the strategic evaluation phase, it is necessary to address the economic evaluation phase, which is referred to as due diligence. The latter consists of calculating the economic value attributable to the identified company. Next, information must be found regarding the possibility of strategic reconciliation and on the convenience, purely, economic-financial of the transaction.
The financial aspect is not to be underestimated that excessive debt may have the consequence of increasing the risk of a lower return on risk capital due to the increased cost of debt capital.
Once the negotiation phase is over, the integration phase begins at this point, which defines both the implementation methods and the harmonization process following the transaction. It is necessary to consider the different managerial cultures, possible barriers, and the strengths and weaknesses of the companies involved in the transaction. Within this phase, it is essential that operational plans are made whose success involves factual collaboration with exchange of experience and expertise gained for a decisive and profitable success of the operation.

2.4 Phases in M&A operations

In dealing with M&A transactions we refer to an entire decision-making process that is gradual and complex and involves a series of choices that must be carefully and punctually evaluated. This process is outlined in several stages that should be considered as such only from a purely theoretical point of view since the realization of the entire process is a continuous becoming with interactions between various stages and phases that sometimes overlap or recur. As Valter Conca[8] points out, in general, the main stages leading to the conclusion of an M&A transaction are the following[9]:

1. Strategic analysis: the process of strategic transactions begins with the strategic analysis phase, which requires the performance of the following activities:
   - Strategic framework of the problem: M&As have as a fundamental point the fact that both companies involved (bidder and target) consider the conditions of exchange listed in the strategic setting (premise) to be valid. Therefore, it is necessary to proceed by 4 steps:
     (a) analysis of the industry, competitors, competitive variables.
     (b) objective recognition of the company's areas of criticality.
     (c) identification of possible economies and synergies that can be pursued.
     (d) verification that the transaction corresponds to the total strategic design.
   - Definition of the objectives of the transaction and identification of the ideal target company; this phase is aimed at understanding the overall context of the transaction and the model of the ideal company to be acquired, following prior assessments. It is necessary to delve into the following points:
     (a) the characters of the target company.
     (b) the timing of the transaction.
     (c) the level of the overall investment.
     (d) the price limit of the economic offer.
     (e) the consequences on the financial and economic plan.
   - Search for alternatives; usually four or five enterprises are identified as potential candidates following well-defined selection criteria including:
     (a) degree of overall strategic fit.
     (b) presence of essential requirements.
     (c) organizational compatibility.
     (d) financial feasibility.

(e) possibility of contact.

2. Negotiation
   The macro-phase of negotiation usually covers multiple stages of the M&A process, which range from initiating contact with the counterparty to finalizing the deal. This activity first involves the identification of the ideal target and the implementation of a sound negotiation strategy to be applied in negotiations. Overall, the negotiation can be summarized in four basic stages:

   (a) the selection of target companies.

   (b) the financial evaluation (concluded to the definition of the price).

   (c) the evaluation of antitrust compliance.

   (d) the formalization of the deal. The success of the negotiation is strongly linked to the quality of the team of professionals involved, sometimes external consultants, supported by internal managers.

3. Due diligence
   The negotiation phase generally concludes with a letter of intent; but the process that lands toward final completion of the transaction requires further procedures: this is the due diligence activity.
   Due diligence is the operation of assigning value to the target company. The latter allows the acquiring party (bidder) to consult company information and check its reliability. Financial advisor figures play an extremely important role in this activity. In fact, due diligence has the ultimate goal of understanding whether the acquiring firm is truly intent on the purchase transaction. The initiative is evaluated in strategic and operational terms; possible inefficiencies and risks that could result from the transaction are identified; and ultimately, the plan for the integration process is outlined through the signing of the contract. Once the latter is signed, the most delicate phase is undoubtedly the process of integrating the two entities into a single company.

4. Post-acquisition phase
   This phase allows operational effectiveness to the entire M&A transaction between multiple realities. Problems and critical issues of the moment are managed to ensure stability for the resulting new entity; initiatives are defined to achieve strategic objectives. The development of operational plans for the managers of the different areas to be integrated and the evaluation of the financial and fiscal effects on the reallocation of operations and personnel are objects of discussion and decision. This part of the process is delicate because managing two realities can lead to serious problems, including social ones, think for example of staff layoffs.
   The best choice that management can make concerns identifying from the

outset the critical factors to manage the integration process in the best and shortest time possible. It is interesting to analyze, in this regard, the model proposed by V. Conca[10]; in which he analyzes four areas of intervention that he defines as "organizational imperatives" necessary to manage the phase in question:

(a) cultural and organizational integration.

(b) consensus generation.

(c) transferability of resources and skills.

(d) containment of adaptation and response times.

2.5 M&A Waves

It is possible to conclude that the scope of M&A operations is value creation gaining a competitive advantage in the market through access to new resources, acquiring a new company (acquiror) or being acquired by a larger entity (target).

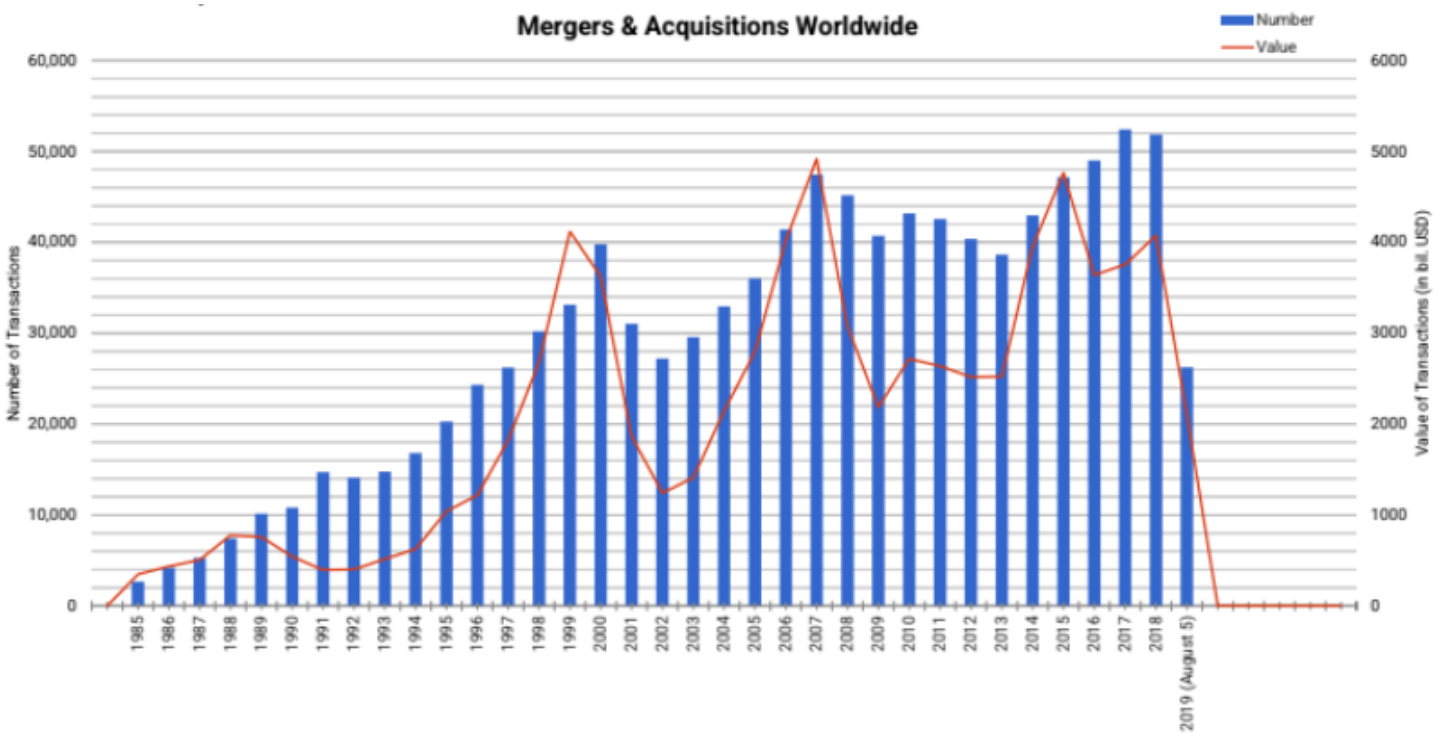

Figure 2.3: M&A Worldwide

As shown in the graph (M&A Worldwide) there are 2 peaks in number of deals and value, the first one is in late 90s (1999) caused by the advent of the Internet, which has made it easier to create, sell and buy companies abroad and media became the new industry. The second in 2007 happened after the market was deregulated and for a listed company became more likely to be sold after restructuring it to a private company, liquidity in the market increases thanks to banks.
M&A occur in waves because they are more likely during economic expansions and "bull" financial markets. Having too many M&As, for whatever reason, it is not good, it is ideal to have regulations put in place to make it more difficult to do a M/A or to say if a company is able to M/A, when it should happen.

- Supposing M&As are due to growth opportunities rather than more liquidity in the market (or investors optimism).

1. If this is the case, then private and public firms should be active in the same way during a wave and outside a wave.
2. If instead market liquidity drives waves, public listed firms should be more active than private firms during a wave.

Empirically, there is more evidence in favor of liquidity drivers. Suppose that M&As waves are driven by growth opportunities so every company would engage in new takeovers when economic forecast is positive. If instead waves are driven by over-optimism, there's a lot of market liquidity, public companies are overvalued because the market is over-valued thanks to the over-optimistic investors.

1. If firms merge to hedge against uncertainty in economic conditions, then waves should start with vertical integrations, or with cross-industry mergers. To survive. If you are afraid a supplier will increase price, disappear, or change the product because of the difficult market conditions, you start to vertical integrate the supplier (buy them) to secure the supply chain. Another reason is that the company's current sector looks grooming for the foreseeable future, then you merge with companies in industries related to yours that you consider have a good future.
2. M&As deals concluded during waves are better quality transactions or not? Empirically, a firm test whether the long-term performance in wave-initiated transactions is better or worse than for deals outside waves. It is rational to expand at some period when it becomes interesting to invest and so other companies also do it. Since everybody is doing it the quality conditions would decrease with respect to other transactions occurring outside the wave. You compare the long-term performance of the two takeovers to prove this statement
3. Market-timing, bidders use overvalued equity to finance acquisitions inexpensively (they "buy smart"). Overvalued means buying more companies. Companies know that when they are overvalued then can use their own stock to finance the takeover.
4. Pre-emptive mergers, defensive strategies (growing to become too big to be eaten)

From joint research between KPMG and Bocconi university it is inferred that the value created by a merge is higher than the one created keeping firms separate.[11] Maintaining this approach on an ongoing basis, according to a clear strategic direction and over the long term, is an accelerator for business growth.

Chapter 3

Innovation and strategic drivers in High Tech Industry

Innovation in high tech industry is the main driver of this industry which is one of the most dynamic and has during the decades many cutting edge events and paradigm changes. One of the most important features is that this sector tries to satisfy customers needs even before they knew them leading companies to perform a continuous process of innovation of their product, process and even organization. Competition between firms is also an important driver for the industry, in a competitive environment every firm needs to undertake a competitive advantage to outplay competitors and became more relevant in the industry.

Innovation plays a significant role in High Tech industry on many levels during the life cycle of a company[12].
First, innovation is crucial to increase competitiveness of a company, the more the company is in early stages of the cycle the more innovation they need to gain market share, innovation allows companies to remain competitive by introducing new products, services or technological solutions. Companies that can innovate effectively often gain competitive advantages, attracting customers and outpacing competition.
Trought innovation a company can better exploit all the potential from a technology or a product improving the lifecycle and avoiding premature obsolescence, gaining also growth under financial and size aspects to reach better positioning in the market and enjoy a better reputation with customers and insiders.

3.1 Resource and capabilities view

Companies pursue innovation to set the interface between the firm itself and strategy, so they focus on the internal enviroment to grow and match market opportunities (external enviroment). This focus is largely used in ustable context, like the hightech market where a new cutting-edge technology could slash out or erode the market share of less captive firms.
The resource based view assert that this kind of stragety is used to create more stable foundation for the strategic planning and that resource and capabilities are the primary determinant of firm's profitability.
In hightech market superio profitability arise from superior valuable resources (Ricaridan Rents)[13]. As for more fertile lands in the theory of Daniel Ricardo, also in high innovation fields a better technology leads to a superior profitability and so to more market share. Investing in resources emphasizes the difference between similar firms, but a resource is not a "competitive advantage", but an input factor.
To perform a task a team of resources must work together, the firm's capacity to develop a resource must be enforced by the capabilities to exploit its potential. Capabilities, or competences, are based upon organizational routine which are "repetitive, recognizable pattern of interdependent actions, carried out by multiple actors" (Feldman and Pentland, 2003)[14].
For research and develpoment the main capabilities are:

- Research capability itself, some exemple are IBM or Merck
- New product development, Apple is still a pioneer in this capability
- Fast cycle new product development, pursued by companies like Canon, Xiaomi or fast fashion companies like Zara

The exemples before are intentionally took from different markets to focus on the importance of this aspect not only in the high tech industry but on the firm's life itself. A metodology to evaluate resource and capabilities is the VRIO framework, which consist in valuate:

- *Value*: does the R/C create a significant economic value in the industry?
- *Rarity*: Is the R/C commonplace or rare aming competitors?
- *Imitability*: is it possible for cometitors to obtain or develop the R/C? and a what cost?
- *Organizational*: Do processes, culture, incentives, organizational structure within the firm allow to support the development or the exploitation of valuable/rare costly-to-imitate resources?

All those question are relevant when evaluating a possible project and its outcomes, even more when the industry is such as the high tech where the opportunity cost is higher than other "traditional markets".
This could be an hint useful to explain why a bigger player externalize innovation obtaining them through acquisitions only when the technology is ready to be commercialized or only partially exploited in its full potential.
The value chain approach (Porter, 1985) is useful to describe how firms evaluate which activities are the most profitable. In this framework, elaborated by Michel

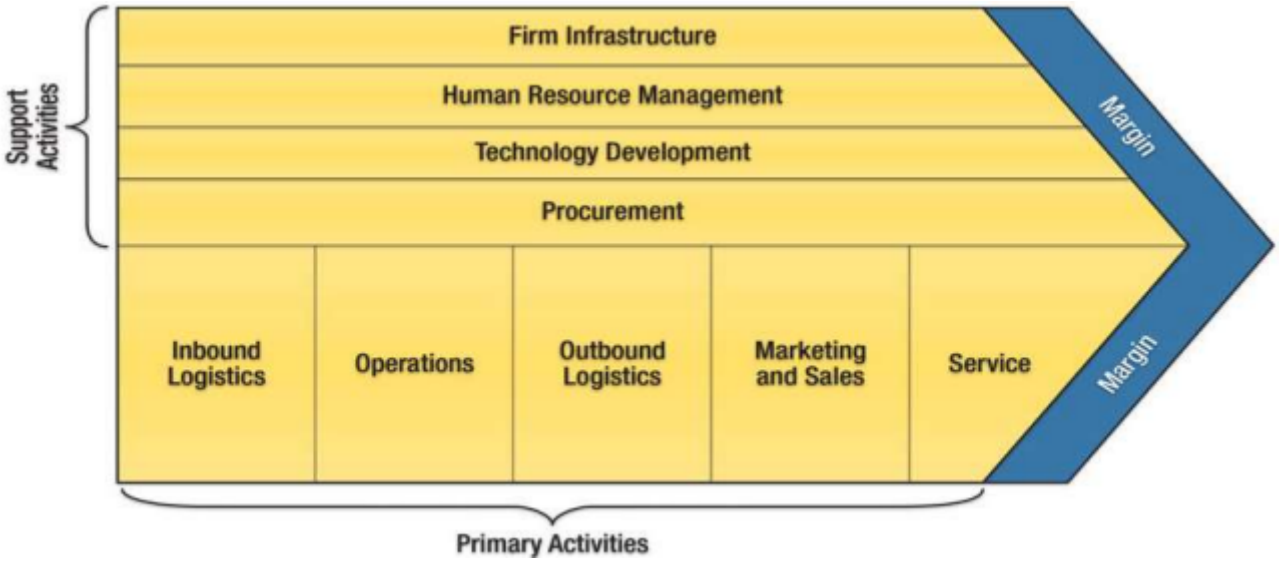

Figure 3.1: Value Chain

Porter, is shown a split between primary and support activities which reflect different impact in value creation. Primary activities have a clear and direct impact on value creation because customers "pays" for their input. Support activities create the conditions for performing primary activities and don't have a direct impact on value.
Focusing on Technology development, it consists of several activities aimed on improving product and processes. For example, R&D development has a specific connotation for managers and sometimes they don't recognize it from technology development, this activity is linked to the engineering department a development group, is an expensive activity with uncertain output and many times the effort is not worth it.
This is the case for a industry player who has a strong position but it's not already a "giant" who can spend such amount of resources on risky projects. A firm who is aiming at expansion may externalize the activity of technology development buying it on the market, even paying a premium respect to develop internally but

with more certainties on the future of the technology. Those two frameworks are crucial in the decision-making process of a firm when the matter are investments in innovation.
VRIO framework helps giving a way to analyse the value of created and value chain analysis helps answering questions about outsource or develop new activities, know if a company is ready to for those activities in terms of resource and capabilities. They help firms to look beyond the boundaries of their own organization and look at the overall industry.

3.2 Industries and firms' lifecycles

Another important aspect is the life cycle is the industry (and firms') lifecycle[15]. The influence that the whole sector has on each firm decision, is directly linked to the stage the whole sector is living. In the traditional view there are 4 phases: Introduction (or early stage), Growth, Maturity and Decline. In the next section all those phases will be analysed.

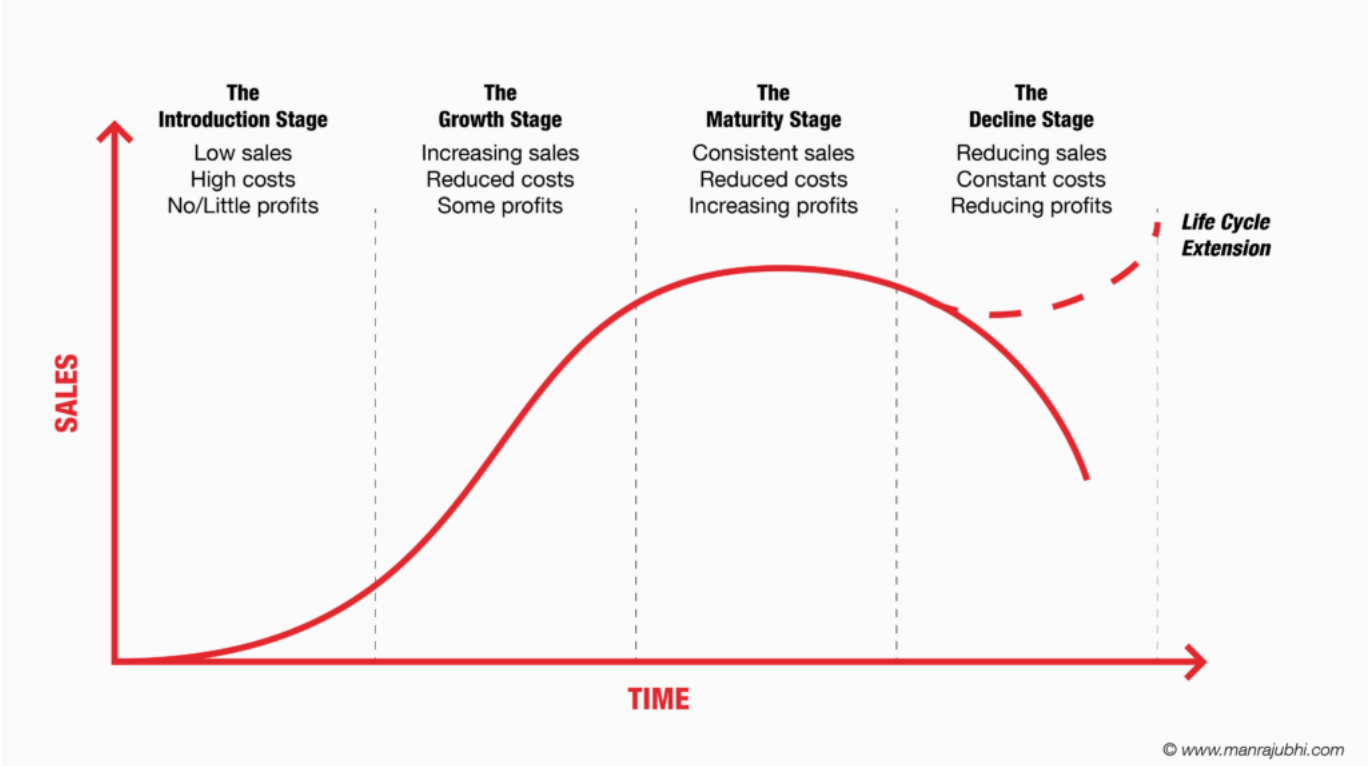

Figure 3.2: Lifecycle of a company

3.2.1 Introduction (early stage):

The early-stage period can be suddenly divided into 2 different phases:

- Idea development
- Set-up period

In the idea development, as the name suggests, the newborn firm is made only by the idea , the inception of the product development. There is no effective product or prototypes but only studies about the market and the feasibility of the product

itself, this phase is the one which requires more capital because, since there is no product yet, the firm face only expenses and, since there are no sources of income, the enterprise il loss-making. The second phase is the set-up period, where the firm prepares all the infrastructures needed to start the business like equipment, production plant, licences and so on. The goal is to reach a certain degree of maturity for the product and start to gain the first revenues or source of income (like rent from intangible assets as patents or similar). In the introduction stage the main risk incurred by firms are technology risk, market risk, capital demand, high expenses and low revenues, years of losses.

3.2.2 Growing stage:

In this stage the firms are characterised by some market share and a more sophisticated portfolio of product/services. The product development and the promotion in the market lead to a constant growth in revenues.
"With technology's improvement and the market's development, risks of technology further reduce, and the market risk began to increase. Because as new entrants to the industry keeps growing, the market competition becomes more and more fierce, and market outlook is full of uncertainty."[16]
This phase must be supported by a growth in organizational structure too, to support the more administrative requirements and mitigate, as possible, the frictions and market risk, a more structured administrative division could also be important to attract investors and be more relatable in the market. In this phase the main risk are the uncertain and unstable cash flows, great capital demand and management risk.

3.2.3 Decline stage

In this phase the technology developed is now out of date, thus the firm is losing market share and so production decreases. The absence of new patent and technology could lead to bankruptcy or, at least, downsizing. The threat of new entrants or change in industry paradigms are some of the main aspects that could led financial and commercial stability obtained in the maturity phase.

3.3 Patterns and S-curve

During each phase it is possible to see changes in the key metrics and performances. The figure below shows standardized mean for some variable in each phase of the life cycle[17].

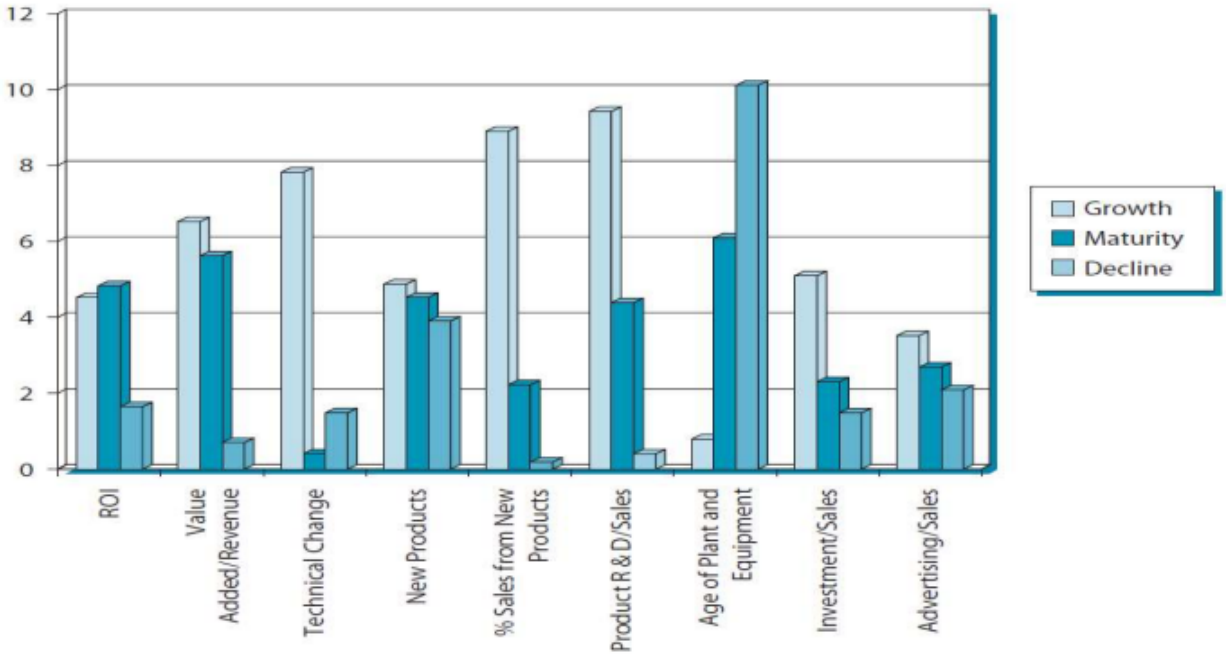

Figure 3.3: Standardized mean for strategic variables

An important indicator is the S-curve[18] pattern. It gives hint about in which phase a product/technology/industry is[19].

As a product approaches its maturity stage, a business should be able to evolve its offer to capture future profit opportunities and maintain actual customers. These new products/services are often an upgrade or complementary of the already existing product/service. One option, for the firm, is to know on which position on the life cycle curve (S-curve) is located, and knowing the slope of the curve, it has an instrument and a measure for determining where its technology is in the lifecycle scheme. Furthermore, the organization can determine the movement's rapidity and find a way to not lose the control over the technology. This type of information must be related with external sources and comparisons to historical data, thus they can be used to predict when an s curve will reach maturity.

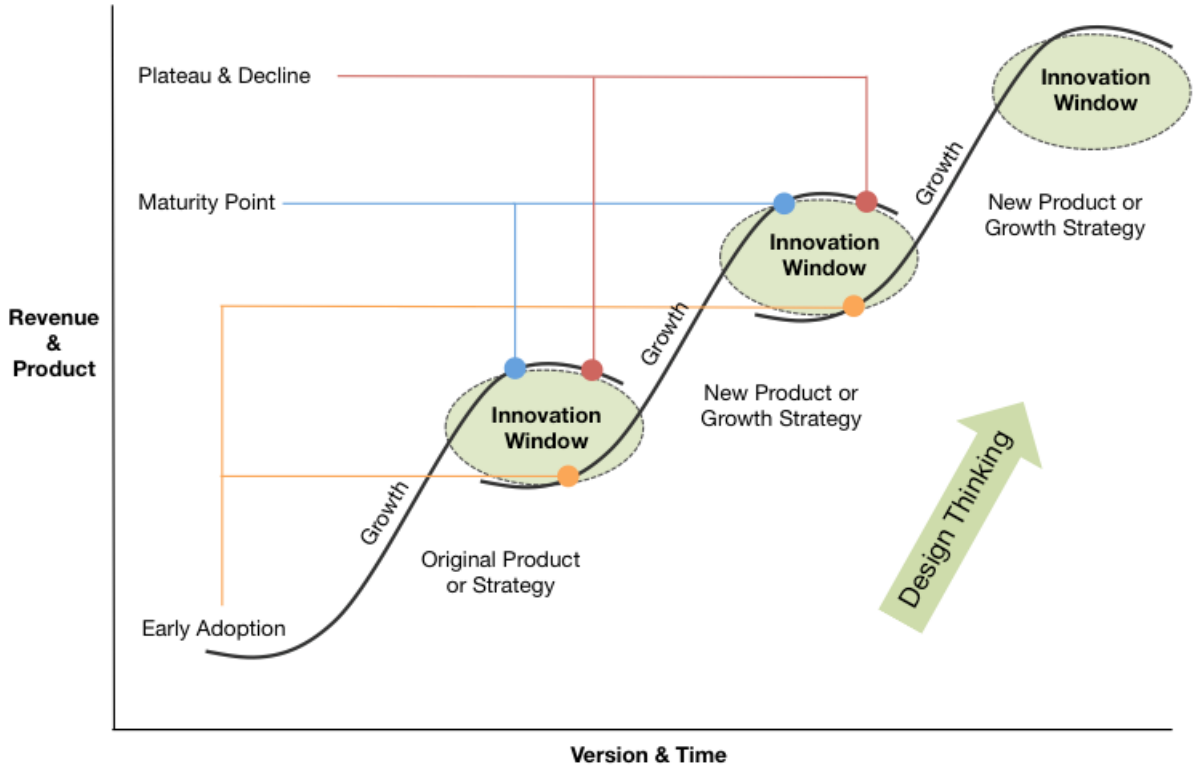

Figure 3.4: S-Curve Pattern

It is helpful to consider the numerous S-curves that can explain how a product or industry is changing over time:

- *Level of invention*: Cutting-edge inventions lead to the creation of new industries. Typically, a high-level solution opens a whole new system of potential ideas and ways of delivering an existing function. For example, the solid state transistor led to the semiconductor industry and manufacture of integrated circuits or the digital camera which almost wiped out the traditional ways to print photos.
- *Number of invention*: As an industry evolves over time, the number of inventions within it gradually rises until the decline stage. For example, the internet opened a door to a whole new wave and invention related
- *Performance*: As an industry evolves over time, the perceived performance of the products within it gradually rises. In the decline stage, the perceived performance declines relative to competing offerings.
- *Profits*: As an industry evolves over time, the profits generated by it gradually rise as the market itself grows until the decline stage

3.4 M&A as a source of innovation

As described in the previous sections, innovation could lead to the creation of new markets which can create new business opportunities. The main aspects are:

- *Diversification of Sources of Revenue*: Through introduction of innovative products or services, a company can diversify its sources of revenue. This diversification reduces dependence on a single market or product, increasing the resilience of the company.

- *Capturing New Market Segments*: Innovation helps to identify and capture new market segments. By introducing innovative solutions, a company can reach previously neglected customers or create new market needs.

- *Competitive Advantage*: Innovation can provide a significant competitive advantage. Companies that first introduce new technologies or innovative approaches can gain a leading position in the market, differentiating themselves from the competition.

In this framework bigger firms can enjoy novels firms or attractive startups to outsource innovation.
Mergers and acquisitions (M&A) can be strategically used to gain innovation in several ways:

- *Access to Technology and Intellectual Property*:
  Acquiring companies with advanced technologies or valuable intellectual property can provide a quick boost to innovation capabilities. This is particularly relevant in industries where technological advancements are crucial, such as the tech sector or pharmaceuticals. An example is Facebook that acquired Oculus VR in 2014, a virtual reality company. This move allowed Facebook to enter the emerging VR market and explore innovative applications beyond social networking. Oculus' technology became the foundation for Facebook's Oculus Rift and subsequent VR initiatives.

- *Talent Acquisition*:
  M&A can be a means to acquire skilled and innovative talent. A target company may have a team of experts or a pool of creative individuals whose skills and knowledge can contribute to the acquiring company's innovation goals. This aspect is directly linked to the resource and capability approach. An example is Google acquiring DeepMind in 2014, through this acquisition it gained access to a talented team of artificial intelligence researchers. DeepMind's expertise has since contributed to Google's advancements in AI, particularly in areas such as deep learning and machine learning algorithms.

- *Expanded R&D Capabilities*:
  Combining research and development (R&D) efforts through M&A can lead to a more extensive and diverse innovation pipeline. The consolidated resources and expertise can accelerate the development of new products, services, or solutions[20]. This aspect is crucial in fast development industries like high tech or pharmaceutical, for example in 2015, the pharmaceutical company Pfizer acquired Hospira, a leader in biosimilars. This acquisition expanded Pfizer's capabilities in the development and production of biosimilar drugs, enhancing its R&D pipeline and positioning the company for innovation in the growing biosimilars market.

- *Diversification and Market Expansion*:
  M&A can provide access to new markets and customer segments. This expanded reach can stimulate innovation by exposing the acquiring company to different consumer needs and preferences. Diversification also allows for cross-pollination of ideas and approaches from different industries. An example is the acquisition of Whole Foods by Amazon in 2017. By integrating a traditional brick-and-mortar grocery chain with an e-commerce giant, Amazon gained insights into the grocery industry, allowing for innovative approaches to online grocery shopping and delivery.

- *Strategic Alliances and Partnerships*:
  M&A can result in the formation of strategic alliances with other companies, opening up opportunities for collaborative innovation. By combining complementary strengths, companies can leverage each other's expertise to drive innovation. An example is the partnership between IBM and The Weather Company (acquired by IBM in 2016). By combining weather data with IBM's analytics and cloud computing capabilities, they developed solutions for industries like agriculture, transportation, and retail, offering innovative insights and applications.

- *Streamlined Processes and Resources*:
  M&A can lead to the consolidation of redundant processes and resources, streamlining operations and allowing for more efficient allocation of resources towards innovation initiatives.

In these examples, M&A served as a strategic tool to gain access to technology, talent, diversified markets, and enhanced financial resources, all of which contributed to innovative advancements in various industries.
It's important to notice that the success of leveraging M&A for innovation depends on effective integration strategies, cultural alignment, and the ability to manage the complexities that arise during the merging of two entities. Additionally, organizations need to be agile and adaptable to ensure that innovation efforts remain a

priority throughout the M&A process.
Economist tried many times to explain the correlation between competition and innovation and thus the function of M&A, the literature can be sometimes contradictory between theories of industrial organization and empirical evidence, Philippe Aghion, Nick Bloom, Richard Blundell, Rachel Griffith and Peter Howitt tried to explain a non-linear relationship called "U-shaped" where patenting activity and the size of the company have a positive relationship until the company reaches large size and so the relationship became negative.
(Capasso and Meglio, 2010) explains that Mergers and acquisitions (M&A) are common strategies employed by firms to improve their performance during the expansion or maturity phase. The study of M&A activities involves a global community of researchers and scholars, leading to the identification of two primary approaches:
A first one based on economic data and information and a second one based on managerial competences and vision.[21]
The economic approach is based on the interaction between various economic actors whose works on a causality effect where the "environment" influences the "inhabitants".
This approach emphasizes the importance of an efficient industrial organization and set as main goal for a company to perform according to the theories in order to suit in the environment and create favourable condition to exploit new solution in the market (for acquiror) or to be more appetible[22] for bigger players (target).
The managerial approach is more focused on the choices operated by the board of director or more generally the executive of the company.
This approach emphasizes the strategic behaviour made by the players in the industry, the organization arrangement in the company is more important but on the human side. According to this approach the decision-making process is more important to the development of innovation in a certain industry, this is strictly linked with the competitive advantage pursued by big players in the industry, leading a company to choose between two options:

- Develop internally innovation through R&D expenses and Capital expenditure.
- Vertical integrate innovation through M&As

There is also a third option where a company diversify risk investing in a company operating in another sector (with a certain degree of knowledge transfer by the parent company to the target company), in this third option the buyer has to improve the organisation of the target in order to create the condition for growth and gain market share.
Philips and Zhdanov[23] suggest that R&D investment is driven by market conditions, the focus of his research is on acquisition market and how the activity

influences investments. Market activity influence the smaller firms investments than large firms, for a large firms it may be not optimal to pursue innovation through Research and development instead of go in the market and buy a smaller firm which could have complementary assets or it could be a potential competitor. According to microeconomic theories for an incumbent company the optimal move is both to accommodate the entry in the market of a new firms and also to improves barriers to entry like price war or patent, the empirical evidence shows that in high tech (or similar innovation driven markets) big players prefer to use the novel companies or startups hub for develop innovations and buy them only when certain conditions are met.
For example a company may decide to buy a company only to access successful projects and giving more incentives for small companies and startups for innovate and pursue the development of new technologies[20].

Chapter 4

The Analysis and dataset preparation

The work of research will focus on target companies willing to achieve innovation and, in certain degree, a competitive advantage in the market against similar companies. The first step is to build a data sample characterized by companies which were acquired in the period between 2005 and 2020 and that had R&D expense in the 3 years before the deal announcement.
A first set of analysis were conducted about the R&D expense correlation and the selected dependent variables. Then the focus shifted on the relationship that the output of R&D had with the selected variables.
Then another set of regression were made to verify if there was a better correlation between the ratio of the dependent variables and the set of independent variables. The effective work is well described in the next section.
The dataset and all the variables were collected using the database Eikon by Refinitive[24], this database contains many tools and information useful for financial service's providers, researchers and students to access all necessary data for their analysis or to build databases. In this case the main function used was the "screener", a function which permits to search many kinds of asset class and filter them. There is a specific class called "M&A" in which is possible to consult an enormous dataset of deals by all the countries consisting largely of public companies. It is also possible to add filters and categories to easily access all the information needed about the companies or the deal itself. The empirical analysis aims to discover which is the relationship between R&D expense and M&A market activity, and thus which are the factors that influence more the R&D activity for target companies. The analysis is based on the theory and the literature explained in the previous chapters, the main focus of the work is to explore which strategic drivers are the most common in the sample of deals, and what are the possible effects that

could have on the target company.
The data collected concern public companies whose reports can be viewed on the relevant stock exchanges (for Italy it is the Italian Stock Exchange[25]).
The main independent variables selected relate to both true business performance, such as ROA or ROIC, and some financial metrics, such as EBITDA, and others purely market-related, such as market multiple (EV/EBITDA). The dummy variables, on the other hand, are modeled on historical data that can be accessed online[26] or in special publications.
The analysis is evaluated through Multiple Regression analysis, performed on Microsoft Excel.
Multiple regression analysis is a statistic model that can be used to analyze the relationship between a dependent variable and several independent variables also called explanatory variables. The objective of the analysis is to predict the assumed values from a dependent variable, starting from knowledge of those observed on several independent variables. The model is based on the equation:

$$y_i = \beta_0 + \beta_1 x_1 + ... + \beta_n x_n + \epsilon \tag{4.1}$$

where y represents the dependent variable, x_1 the first independent variable, x_m the m-th independent variable.
β is the intercept, namely the value that y would have if all the independent variables are equal to zero, β_1 the coefficient of the first independent variable which express the change in y for a unitary change in x_1 keeping the rest of the equation fixed, β_mm the coefficient of the m-th independent variable which express the change in y for a unitary change in x_m keeping the rest of the equation fixed.
ϵ which represents the experimental error, accounting for variability in the behavior of the dependent variable.
Two hypothesis tests can be performed, one aimed to test the significance of the whole regression model and the other to test the significance of the various coefficients.
The first mentioned test is performed calculating the F of Snedecor, by dividing the mean of regression squares for the mean of residuals squares. The significancy is evaluated then using F distribution tables and looking at the p-value. A p-value lower or equal to 0,05 implies the significancy of the whole model.
The second test, instead, is performed for each coefficient and implies the calculation of Student's t. The evaluation of significancy is performed looking at the p-value and consulting the T tables. A p-value lower or equal to 0,05 implies the significancy of the coefficient.
A metric which is useful to understanding the value of the model built is the R squared which estimates the proportion of variance explained by the model. The R squared is calculated dividing the sum of residuals' squares by the sum of total squares. R squared values can range from 0 to 1. A value of R squared equal to

zero implies that the model does not explain the variance of y, while a value equal to one would mean a perfect model that explain completely the variance of y.
A problem with this kind of model is multicollinearity, it happens when many independent variables are highly correlated between themselves, diminish the predicative capacity of the whole dataset. Another problem is representativity of the sample, even if all the deals are taken with no country or size restrictions, it is possible that some other options are not considered. For example the database is able to extract only data about public firms and only for successful deals, the portion of firms that are not considered may result usefull in order to give a better view on the the problem analyzed.

Chapter 5

Results

The multiple regression analysis presented in the previous chapter has been performed on a dataset built with various periods and transactions to reflect a certain degree of realism between the sample analysed and the reality of the whole industry. For each case evaluated, a different model has been built to have more accuracy and a complete analysis on the factor that may afflict investment decision in high tech industry. At the end 2 models have been built:

- R&D expenses of target company
- Intangible assets held by target company

5.1 R&D Expenses

In the first model is presented a sample of 360 observations which are deals announced in the period between 1st January 2005 and the 31st December 2020 where the target company belongs to High Tech Industry, for the acquiror no restriction were applied.
The sample is composed only by target companies which performed R&D expenses at least during the last year prior the announcement. Firms are located all over the world, many factors were taken into account like the type of deal (tender offer, self-tender, hostile acquisition), the status of the company (public or private), verticality of the deal, Capital Expenditure, total asset of the company, share price in p.p.1 of the deal, share price paid by the acquiror company, net sales in p.p.1 , Enterprise value on EBITDA (a market multiple representing the valuation of the company respect to the book value of his real value), Earning per share, Price earnings ratio.
In the table below is shown the last combination of these factors which gave a statistically significant result: In this last model the factors are reduced to 8,

Table 5.1: Variance analysis - R&D Expense

	Degrees of freedom	Sum of Squares	Mean Squares	F	Significancy of f
Regression	8	8346452,52	1043306,57	26,85	2,133E-32
Residuals	351	13638893,1	38857,2452		
Total	359	21985345,6			

Table 5.2: Regression's statistics - R&D expenses

Regression's statistics	
Multiple R	0,616146967
Squared R	0,379637085
Adjusted Squared R	0,36549776
Standard Error	197,1224118
Observation	360

	Coefficients	*Standard error*	*T statistic*	*Significancy Value*	*Inferior 95%*	*Superior 95%*
Intercept	22,78268543	26,66701316	0,85434	0,393499562	-29,66454434	75,22991519
Share Price	0,443810262	0,222226252	1,99711	0,04658491	0,006747768	0,880872756
Share paid	0,522507639	0,286875771	1,821372	0,069401353	-0,04170401	1,086719287
Net sales	0,04947812	0,003609216	13,70883	1,48823E-34	0,04237971	0,056576529
EV/EBITDA	0,360581991	0,407021418	0,885904	0,37627567	-0,439925576	1,161089558
Debt/equity	-7,553547655	8,388529018	-0,90046	0,36849208	-24,05164986	8,944554555
EpS	-6,441186766	3,452613046	-1,8656	0,062931712	-13,23159815	0,349224616
Dummy private/public	-8,917893002	24,72183335	-0,36073	0,718518714	-57,539449	39,703663
Dummy year	-14,18593819	21,08062619	-0,67294	0,501430022	-55,64616618	27,27428979
Intercept	22,78268543	26,66701316	0,85434	0,393499562	-29,66454434	75,22991519

Figure 5.1: R&D Expense Regression

among these 8 factors 2 of them are statistically significant, and so affect the R&D expense made by target company.
The 2 factors are Share price p.p. and the Net sales, with respectively a significance value of 0,04658491 and 1,48823E-34. It could be relevant to also mention the share price paid by the acquiror; with a significance value of 0,069401353, and EpS, with a significance value of 0,062931712, that are higher than the target 0,05 value to be significant but not so much so with another kind of sample may be significative. This problem could be solved obtaining more data about companies which are not public, but this is an activity with many problems especially for the companies located outside EU or USA.
Looking at the variance analysis is important to look at the squared R, since this is a multiple linear regression, it is better to look at the Adjusted squared R; these two factors will be very close when the sample is large enough and in this model the difference is only of 0,014139326.
Adjusted squared R measures the percentage variance shared by the independent and the dependent variables and is always between 0 and 1. The higher is the value the better is the predictive model but in many cases as the behavioural research this value is around the 50%. This specific model can be interpreted in a certain way as a behavioural model for the choices of a company to invest or not so this value is aligned with other studies, anyway the adj squared R alone is not sufficient to determine if a model is suitable or not for a certain event. It is always necessary to look at the F test and the significance of this test, for the model presented F is 26,84973059 and the significance is 2,13302E-32, those results shows that the influence of the independent variables over the dependent is not casual and so the model is correctly predictive. The model presents a weakness under the Standard Error value, which is too high, but it could be affected by the values used as dependent variable, since it describes a statistical variation it is better to look also at the Sum of squares and Main squares data to see how these values are influenced by the R&D expenditure itself and the other variables (those are expressed in $ millions). Analysing the coefficients given by the model we can observe that the line expressed is upward sloping because of the positive value of the coefficient (22,78268543).
The 2 relevant regressors also presents a positive coefficient (0,443810262 for the Share Price and 0,04947812 for Net Sales), this information tells us that an increase in one of the 2 values reflects in an increase in the depend variable (R&D expenditure). Even if the other regressors are not relevant it may be useful to interpret the coefficient given by the model and then with other models explore test if those assumptions remain still relevant. Share price paid by the acquiror (i.e. the share price plus a premium) presents a positive coefficient suggesting that if the price paid by acquiror company is larger a firm tend to increase his expenditure in research and development.

The multiple paid by the acquiror (EV/EBITDA) is also positive correlated with the R&D expense suggesting that higher multiples may influence investment decision by a potential target company, since the multiples are given by the overall market activity and not under the full control of the acquiror company it is right to suppose that in years with higher multiples the overall R&D expenses.
The dummy variable "Year" suggests the opposite view, its coefficient is negative (-14,18593819). The variable is built using historical data about the number of transactions in M&A during the las 20 years and is set as 1 when the deal occurred in the period between 2020-2016 and 2007-2004 because during the timespan between the two intervals it can be noticed a substantial reduction of the transactions per year.
At a first look this information goes against the assumptions made about the multiple, on the other hand this regressor hide the information that a more active M&A market gives more opportunities to be acquired but also more competition between all the potential target companies and so a company with less certainty about their R&D projects could choose to exit the race or try to invest to more certain projects.
The other dummy (private vs public company) presents also a negative coefficient, and this relationship can be suggested by the process of going public by a company (IPO). This is process is a way to reach new capital and fuel new ambitions and projects thought the financial constrains remove and an increased liquidity, but the process may cost a lot for a company; for example, there are monetary costs like the audit cost for the account verifications and the various fees for legal consulting and the underwriter which sells the shares to the public. There are also non-monetary costs like the dispersed ownership which increase the time to market for certain projects like strategic ones or the ones with are more capital intensive. At the end the choice of going public can be more problematic for companies which are not ready for this step and can have a negative impact on the decision of investment.
The last regressor presented by the model is the financial leverage of the company, it shows a negative coefficient (-7,553547655) which can be explained by the fact that a certain degree of debt is necessary for a company, but the more debt you obtain the less free to invest you are.
Financial leverage is the ratio between the Total debt of the company and the shareholders equity and so a too much higher debt degree can reflect in less projects undertaken by the company especially under higher uncertainty through the markets or the project itself.

5.2 Intangible Assets Held by target company

In the first model is presented a sample of 343 observations representing deals announced in the period between 1st January 2005 and the 31st December 2020 where the target company belongs to High Tech Industry, for the acquiror no restriction were applied. The sample is composed only by target companies which present significant data about intangible assets in their balance sheets. Firms are located all over the world, many factors were taken into account like the type of deal (tender offer, self-tender, hostile acquisition), the industry where the company operates, intangible assets held by acquiror, leverage, market multiple paid by acquiror, R&D expense was tested as well and net sales. In the table below is shown the last combination of these factors which gave a statistically significant result: In this last model the factors are reduced to 5. Among those factors

Table 5.3: Variance analysis - Intangible assets

	Degrees of f.dom	Sum of Squares	Mean Squares	F	Significancy of f
Regression	6	1080673709	180112285	165,8636	2,8808E-97
Residuals	366	364864453	1085906,11		
Total	342	1445538162			

Table 5.4: Regression's statistics - Intangible assets

Regression's statistics	
Multiple R	0,864634404
Squared R	0,747592652
Adjusted Squared R	0,743085378
Standard Error	1042,068189
Observation	343

only one is statistically significant, Net sales, with a value 1,23692E-76. Also, the intercept has a significance value (0,002687501), this information may be significant to understand the model since the intercept is the value that the predicted variable will have when all the regressor are equal to zero.
The whole model presents a value of F is 165,863589 and a significance value of 2,88075E-97, which is also the closest to zero between the various models created and analysed during this study. The model seems to be able to predict the observed value through the regressors, the squared R is equal to 0,747592652 but, since is a multiple regression, is more useful to look at the adjusted squared R which as a value of 0,743085378.
As said in the previous section, the larger is the sample the closer will be those two

	Coefficients	Standard error	T statistic	Significancy Value	Inferior 95%	Superior 95%
Intercept	0,011229575	0,00582091	1,92918006	0,05455041	-0,00022043	0,02267958
Debt to equity	-41,9979955	45,0458816	-0,93233818	0,35183123	-130,605469	46,6094782
EV/EBITDA	-0,31333621	1,69243987	-0,18513876	0,85323191	-3,64244902	3,0157766
R&D	-0,12243515	0,28119309	-0,43541306	0,66354219	-0,67555584	0,43068555
Net Sales	0,601640493	0,02459005	24,4668257	1,2369E-76	0,55327065	0,65001034
Dummy industry	148,2269423	115,390541	1,28456753	0,19982837	-78,7519495	375,205834

Figure 5.2: Intangible Assets Regression

values; the model presents a difference of 0,004507274. This adj squared R value is more close to 1 than the previous one, in fact this model is less behavioural than the first one, testing the intangible assets the focus isn't on the decision itself but on how the target companies exploited their investment in R&D (this is the reason behind the R&D expense as one of the regressors) and so test if a good project, which lead to patents, software or other kind of intangible assets, will make more attractive a certain company as source of innovation for a bigger player. As well as the previous model, the standard error is a very high value (1042,068189) and Sum of squares and Main squares present higher values. This is caused by the variables expressed in $ millions, with some cases where reach peak of $ billions.
This model is more predictive than the previous one, but the bigger errors value suggests the presence of many outliers. The model presents an intercept of -290,7020093 so in the case of all regressors equal to zero the intangible assets start by a negative value, this seems an absurd assumption but can be explained looking at the whole model itself, supposing a company with no sales or debt or expenses in projects it is obvious that there are no intangible assets or assets in general.
The negative intercept can be explained thinking at other factors not considered on the analysis, like cost of production taxes and the cost component of a business, the reason behind this negativity must be seek in what remain in the company after all costs incurred in a certain period. Net sales present a coefficient of 0,601640493 very close to 1, it is positive so there is a positive correlation between net sales and intangible assets, it seems a normal relationship for a company in a growth phase of its lifecycle.
Even if is beyond the threshold of 0,05; Intangible assets held by acquiror company (with a significancy value of 0,054550405) can be analysed because of the importance of complementarity of assets. In the model the coefficient is 0,011229575 which gave a hint about the kind of deals more present in the sample. It is not wrong to assume that this value is influenced by a strong presence of mergers or synergies between companies with similar size to avoid being eaten by bigger players in the market or companies with a poorer percentage of intangible assets that outsource this kind of source of innovation.
The market multiple paid by the acquiror present a negative coefficient (-0,313336214) which means that companies that have a good intangible assets portfolio are less overpaid than others. R&D expense have a negative coefficient (-0,122435145). It could be unintuitive, but this relationship is probably linked to the efficiency of the expense. A company which spends a lot in research and development without exploiting any project have fewer intangible assets or a smaller portfolio. On the other hand, this coefficient can also be biased by on-going projects which require other years of research and/or prototyping to successfully reach the desired output.
Financial leverage is the ratio between the Total debt of the company and the shareholders equity and so a too much higher debt degree can reflect in less projects

undertaken by the company especially under higher uncertainty through the markets or the project itself.

5.3 Ratios

Since the results displayed in the previous models were not exhaustive, another metric that is interesting to test is the R&D intensity (i.e. the ratio between R&D and net sales, the most significant regressor in the previous model).
To build this model the focus was set on some performance indicators for a growing company:

- *Share price*: a metric to know the value of the company and what investors think of their business in the period took under analysis.
- *Share price paid by investors*: a metric to give a hint about the premium paid by investors for each capital injection which could occur in the period under analysis.
- *Leverage*: this metric was put in the model to test again if the possible misalignment of interest can interfere in the innovation pattern pursued through R&D.
- *EV/EBITDA*: a measure to test if the market multiple can affect investment decisions.
- *P/E ratio*: a measure to have both an economic and financial hint about the real value and the value perceived on the market about the company.
- *EBIT YoY*: a different measure of how company is gaining market shares through the years, it is also a substitute of net sales since this metric is now part of the dependent variable.
- *ROA*: return on asset is an important indicator for the company since it is a measure of how asset are exploiting their economic value and potential
- *ROIC* : return on invested capital can give an hint on how those investments are producing value
- *Dummy Year*: this dummy assumes the value of 0 if the deal occurred in the period between 2009 and 20116, otherwise assumes the value of 1.
- *Dummy public*: a dummy variable which assume the value of 1 if the company was public, 0 otherwise

This model is also tested on three different years before the deal announcement to test also if the is the deal itself to stimulate innovation, and so R&D intensity, or if is the willingness to be acquired the main fuel of the R&D intensity in the market.

5.3.1 R&D intensity (three years prior deal announcement)

The first model is the R&D Intenisty 3 years prior deal announcement

Table 5.5: Variance analysis - R&D Intensity 3 y.p.

	Degrees of freedom	Sum of Squares	Mean Squares	F	Significancy of f
Regression	9	0,5204	0,0578	5,5686	3,5167E-07
Residuals	344	3,5719	0,0104		
Total	353	4,0923			

Table 5.6: Regression's statistics - R&D Intensity 3 y.p.

Regression's statistics	
Multiple R	0,356599912
Squared R	0,127163497
Adjusted Squared R	0,104327659
Standard Error	0,101899375
Observation	354

In this first model is performed on a partial sample of 354 companies, instead of 360 as the complete sample, because some of them were not existing in the timespan considered.
Those firms are located all over the world were all acquired, the announcement date was 3 years after the occurrence of the data used. All the deals occurred in the period between 1st January 2004 and 31st December 2020, the target companies belong to high tech industry and no restrictions were applied to the acquiror companies.
The sample is composed only by target companies which performed R&D expenses in the year considered (t-3, where t is the announcement date). The model presents an F of 5,568593253 and a significancy value of 3,51672E-07.
The total regressors considered were 9. Among these 9 regressors 3 were statistically significant, Ratio of EV to EBITDA (i.e. Market multiple paid by the acquiror), EBIT YoY and ROIC. Those three regressors present a significance value respectively of 0,000276931, 0,007716431 and 0,032156437. Those three regressors have significant and thus affect the R&D intensity, they're under the threshold of 0,05 and those values shows an improvement respect to the first model where only 2 regressors were significant. The Sum of Squares and the Main Squares shows a little dispersion in this model with respectively 0,52039252 and 0,057821391. This model is more variable than the other presented in previous section, the Squared R

	Coefficients	Standard error	Tstatistic	Significancy Value	Inferior 95%	Superior 95%
Intercept	0,030550406	0,046647375	0,6549223	0,512955455	-0,06119957	0,122300382
Target High Share Price 3 Years Prior	-8,15612E-06	5,37109E-06	-1,5185224	0,129801249	-1,87204E-05	2,40819E-06
Ratio of Enterprise Value to EBITDA	0,000768319	0,000209129	3,67390233	0,000276931	0,000356987	0,001179651
P/E ratio	2,83577E-05	1,73121E-05	1,63802828	0,102330113	-5,69317E-06	6,24085E-05
debt tp equity	-0,001036463	0,002585294	-0,4009073	0,688737301	-0,006121437	0,00404851
Ebit yoy	-0,000642229	0,000239638	-2,6799986	0,007716431	-0,001113569	-0,000170889
ROA	-0,060790617	0,032893281	-1,8481166	0,065443644	-0,125487886	0,003906652
ROIC	-0,000550131	0,000255732	-2,1511989	0,032156437	-0,001053127	-4,71353E-05
Dummy year	-0,002146204	0,011772339	-0,1823091	0,85544758	-0,02530103	0,021008622
Dummy public	0,074137661	0,046133287	1,60703184	0,108964835	-0,016601165	0,164876487

Figure 5.3: R&D Intenisty 3 y.p. Regression

is equal to 0,127163497and the adjusted Squared R to 0,104327659.
The Squared R and the adjusted R presents a higher delta than the precedent models (0,022836) even if the sample size is the same. This higher variation could be explained by the presence of some important outliers in the model.
The first significant regressor is EV/EBITDA, the coefficient is equal to 0,000768319, this shows a positive correlation between the regressor and the dependent variable suggesting that the higher is the market multiple the more firms are willing to increase the intensity of their investment in R&D. This information in a model created starting by data obtained 3 years prior the effective announcement date suggest that R&D intensity can be a driven by the opportunity in M&A market.
The second significant regressor is the EBIT YoY, the coefficient is equal to -0,000642229. This shows a negative correlation between the growth of Year over year of the Ebit and the R&D intensity. The hint about this negative correlation can be found in the growth rate of the firms. They may invest in some project which can lead to a fast growth in terms of revenues or improve their organizational arrangement and so the R&D intensity may decrease because of the increase of the business while R&D expense remain fixed.
The third significant regressor is ROIC (Return On Invested Capital), it presents a coefficient of -0,000550131. This relationship suggests a negative correlation between the regressor and the R&D intensity, to seek the meaning of this relationship it could be important to first analyse the framework in which the model is. First of all the period took in consideration is 3 years prior the announcement date, so target firms are still trying to exploit successful projects in order to be more appetible for bigger players and so an higher ROIC will suggest that the project undertook is already capable to generate revenues and/or passive income, so an increase in R&D intensity is more probable with a lower return that lead to amply the projects portfolio. It is also possible that a certain technology developed is not properly ready for the market and thus not capable of generate appropriate return and so more investment are needed to improve the technology or exploit other applications for the technology.

5.3.2 R&D intensity 2 years prior

The second model is the R&D Intenisty 2 years prior deal announcement

Table 5.7: Variance analysis - RD Intensity 2 y.p.

	Degrees of freedom	Sum of Squares	Mean Squares	F	Significancy of f
Regression	9	0,40178	0,04464	6,4754	1,91213E-08
Residuals	308	2,1234	0,00689		
Total	317	2,525			

Table 5.8: Regression's statistics - RD Intensity 2 y.p.

Regression's statistics	
Multiple R	0,3989
Squared R	0,15911
Adjusted Squared R	0,13454
Standard Error	0,08303
Observation	318

In this second model is important to notice that not all the 360 firms, and not even the 354 of the previous one, are present because of information missing or because firms didn't not perform any kind of R&D in the period considered.
The model presents an F of 6,475411598 and a significancy value of 1,91213E-08. In the 2 years prior model total regressors are still 9, among those regressors 3 of them are significant (and the intercept too). The significant regressors are EV/EBITDA (i.e. the market multiple paid in an acquisition) with a significancy value of 1,63252E-07; Ebit YoY with a significancy value of 0,004408942 and ROA with a significancy of 0,015109023. Respect to the previous model, it is important to notice an improvement in the Squared R and the Adjusted Squared R, going from respectively 0,127163497 and 0,104327659 to 0,159110272 and 0,134538819. This model presents less variability than the previous one also because in the second year of investments the correlation between the variables and the investment decision may increase.
Also the standard error is improved as well, going from a value of 0,101899375 to 0,083030367, between the 2 models there is a difference around 20% (decreased in this second model). The degrees of freedom didn't follow this reduction trend but are still 9 as in the previous model.
This model shows a positive correlation between EV/EBITDA and the R&D

	Coefficients	Standrard error	T statistic	Significancy value	Inferior 95%	Superior 95%
Intercept	0,096060633	0,009103587	10,551954	2,00668E-22	0,078147541	0,113973725
Target Share Price 2 Years Prior	-1,71393E-05	2,08025E-05	-0,82390559	0,410630739	-5,80722E-05	2,37937E-05
Ratio of Enterprise Value to EBITDA	0,00094579	0,000176446	5,36023344	1,63252E-07	0,000598599	0,001292982
P/E Ratio	1,92972E-07	8,30616E-06	0,02323244	0,981479903	-1,6151E-05	1,6537E-05
Debt to equity	7,85483E-06	0,000369979	0,02123047	0,983075553	-0,000720152	0,000735861
Ebit yoy	-0,000592644	0,000206604	-2,86851013	0,004408942	-0,000999177	-0,000186111
ROA	-0,156512008	0,064053867	-2,44344353	0,015109023	-0,282550547	-0,030473469
ROIC	0,000504911	0,000869022	0,58101124	0,56165778	-0,001205059	0,002214882
Dummy Public	-0,003967049	0,019027101	-0,20849467	0,834980557	-0,0414066	0,033472502
Dummy year	0,006885885	0,018278878	0,37671267	0,706646538	-0,029081396	0,042853116

Figure 5.4: R&D Intenisty 2 y.p. Regression

intensity with a coefficient of 0,00094579, confirming that a higher multiple paid on the market is positively perceived by the management of the firms and could induce them to increase the amount of resources allocated in this kind of projects.
EBIT YoY is once again negatively correlated with R&D intensity, this regressor presents a coefficient of -0,000592644. As said in the previous section the reason behind this correlation should be sought in the performance that a company may have, if a certain project requires fixed amount of investment per year and the company doesn't have any other projects to undertake, a growth in EBIT and in sales will reduce the R&D intensity (calculated as R&D expense on Net sales).
The last significant regressor is ROA (Return On Asset) whit a coefficient of -0,156512008. The regressor and the dependent variable are negative correlated, as in the previous model, showing an hint similar to the previous one, a well performing company may not be convinced in increase it's investment in R&D despite an higher return on their project. As predictable, the regressor in this second model became significant and able to predict the dependent variable but , surprisingly, ROIC is now not significant.
All the three regressors are more significant and present an higher correlation respect to the previous model suggesting an increasing correlation between regressors and predicted variable as the deal announcement date get closer.
Overall the other regressors are far away from being significant in the predictive model but it show an improvement from the "3 years prior" model.

5.3.3 R&D intensity

The third model is the R&D intensity a year prior deal announcment.

Table 5.9: Variance analysis - RD Intensity 1 y.p.

	Degrees of freedom	Sum of Squares	Mean Squares	F	Significancy of f
Regression	9	0,37106	0,04122	6,1809	4,2629E-08
Residuals	350	2,3346	0,0067		
Total	359	2,7057			

Table 5.10: Regression's statistics - RD Intensity 1 y.p.

Regression's statistics	
Multiple R	0,37032
Squared R	0,1371
Adjusted Squared R	0,1149
Standard Error	0,0817
Observation	360

In the last model the R&D intensity in the year prior the announcement is analysed, the sample is composed by all the original 360 firms which were part of a transaction which was announced in the period between 1st January 2004 and 31st December 2020.
The model takes in consideration all the factors analysed before except the dummy about the public status of the company, this exclusion was made because this regressor gave problems in the regression affecting the whole model and the variables, once excluded the model predictive capacity increased and a better fit was achieved. The total regressor decreased to 8 and among these 8 regressors 4 of them were significant, EV/EBITDA (the market multiple paid by acquiror company) with a significancy value of 3,08632E-06, the financial leverage with a significancy value of 0,017932808, ROA (return On Assets) with a significancy value of 0,024575856 and EBIT YoY with a significancy value of 0,000118192.
Respect to the previous model, it is important to notice a step back in the Squared R and the Adjusted Squared R, going from respectively 0,159110272 and 0,134538819 to 0,137140169 and 0,114952345. This model presents more variability than the previous one probably because the sample size increases and so the presence of possible outliers and other uncorrelation causes like the intrinsic variability of the dependent variable.

	Coefficients	Standard error	Tstatistic	Significancy Value	Inferior 95%	Superior 95%
Intercept	0,030550406	0,046647375	0,6549223	0,512955455	-0,06119957	0,122300382
Target High Share Price 3 Years Prior	-8,15612E-06	5,37109E-06	-1,5185224	0,129801249	-1,87204E-05	2,40819E-06
Ratio of Enterprise Value to EBITDA	0,000768319	0,000209129	3,67390233	0,000276931	0,000356987	0,001179651
P/E ratio	2,83577E-05	1,73121E-05	1,63802828	0,102330113	-5,69317E-06	6,24085E-05
debt tp equity	-0,001036463	0,002585294	-0,4009073	0,688737301	-0,006121437	0,00404851
Ebit yoy	-0,000642229	0,000239638	-2,6799986	0,007716431	-0,001113569	-0,000170889
ROA	-0,060790617	0,032893281	-1,8481166	0,065443644	-0,125487886	0,003906652
ROIC	-0,000550131	0,000255732	-2,1511989	0,032156437	-0,001053127	-4,71353E-05
Dummy year	-0,002146204	0,011772339	-0,1823091	0,85544758	-0,02530103	0,021008622
Dummy public	0,074137661	0,046133287	1,60703184	0,108964835	-0,016601165	0,164876487

Figure 5.5: R&D Intenisty 1 y.p. Regression

On the other hand, the standard error presents a little decrease from 0,083030367 to 0,08167255 showing that even if with a higher variability the regressors tend to estimate well the variable. The degrees of freedom remain the same (9) in this model as the 2 before giving another hint about the change in Squared R and the sample size influence on the model variability.
The model shows a correlation between EV/EBITDA and R&D intensity, with a coefficient of 0,000817077 confirming the positive correlation shows in the models before.
EBIT YoY is significant with a coefficient of -0,000788131, confirming the negative correlation of the first two models and the hint that for a better performing firm is less useful to be acquired since it's able to exploit the economic return of their innovation.
ROA presents a coefficient of 0,001029174, surprisingly positive despite the results showed in the previous model. The hint given by this relationship is that in the last year before the deal, a possible target company may try to improve their financial or try to improve it's return to be more well-looking at the eye of a potential acquiror showing that the technology developed is already able to generate any kind of revenues.
In this third model a fourth significant coefficient emerges, Financial leverage, with a coefficient of -0,00800784. This relationship became significant only in the model 1 year prior the deal announcement, the negative relationship suggests that a higher leverage decrease the intensity of R&D investment because debtholders are remunerated first and thus implies that the majority of population composing the sample are firms in early stage of their lifecycle that prefer to finance their operations and investments with equity.
These 3 models show how a more other multiple paid in the market positively influences R&D intenisty, this result suggests that R&D activities can be increased with a view to being acquired. The negative correlation with EBIT YoY suggests that the firm either once it grows does not wish to be acquired or, more realistically, the increase in R&D expenditures is supported by a decline in EBIT. ROA in one of the two models (3 y.p) is negatively correlated while in the last one it is positively correlated, these results lead to the idea that initially the investment in R&D is related to a decrease in operating results while in the last period there is an actual improvement in performance. This result is even more significant in light of the relationship with the market multiple and the fact that the dataset consists solely of successful deals.
ROIC and financial leverage are significant in only one model each, 2 y.p. for the former and 1 y.p. for the latter. While a similar reasoning can be made for ROIC as for ROA, for financial leverage, which has a negative correlation, it can be assumed that only firms that do not have an excessive portion of debt are appealing to larger players and are thus able to sustain investments in R&D in a more solid way.

In the next model we will delve into the relationship from the output of research and development and the selected metrics.

5.3.4 Percentage of Intangible Assets

The last model prepared is the ratio of intangible assets on total assets, this measure was studied to find a relationship between the output of R&D development and the investment made to gain such innovation.
The regressors analyzed are:

- *Ratio between Intangible assets and total assets held by acquiror company*: this regressor is taken into account to test how the asset portfolio of target and acquiror are related, in order to obtain information about the verticality of the deal and the complementarity of assets.
- *Capex*: Capital Expenditure refers to the funds a company invests in acquiring, upgrading, and maintaining physical assets or long-term assets with the aim of improving its overall operational efficiency, capacity, or capabilities, it includes Purchase of Property, Plant and Equipment, Infrastructure investments, R&D expenditure, Software and IP. This regressor is useful to understand how the funds are used by the company to increase thei intangible assets.
- *Financial Leverage*: this metric is analyzed to obtain information about the how the assets are obtained and to see if the prospect of a deal push the company to increase its debt.
- *EBIT YoY*: a different measure of how company is gaining market shares through the years, it is also a substitute of net sales since this metric is now part of the dependent variable.
- *Net sales*: this metric is taken into account to track company's presence in the market.
- *ROA*: the return generated by the assets in their totality.
- *Dummy year*: as in the previous models this dummy assumes the value of 0 if the deal occurred in the period between 2009 and 2016, otherwise assumes the value of 1.

Table 5.11: Variance analysis - Percentage of Intangible Assets

	Degrees of freedom	Sum of Squares	Mean Squares	F	Significancy of f
Regression	7	3,2812	0,4687	15,7489	3,7278E-18
Residuals	379	11,2804	0,02976		
Total	386	14,5616			

Table 5.12: Regression's statistics - Percentage of Intangible Assets

Regression's statistics	
Multiple R	0,47469
Squared R	0,2253
Adjusted Squared R	0,2110
Standard Error	0,1725
Observation	387

	Coefficients	*Standard Error*	*T statistic*	*Significancy Value*	*Inferior 95%*	*Superior 95%*
Intercept	0,095229899	0,018097882	5,261936	2,39068E-07	0,059645065	0,130814732
INT/TOT assets acquiror	0,399589871	0,042370979	9,430744	4,16325E-19	0,316278231	0,482901511
Capex	3,03888E-05	6,45118E-05	0,471057	0,63787085	-9,64571E-05	0,000157235
Financial Leverage	0,006057959	0,007066824	0,857239	0,391854367	-0,007837133	0,019953052
EBIT YoY	0,000852015	0,000405357	2,101888	0,036222516	5,49848E-05	0,001649046
Net sales	2,75437E-06	4,40712E-06	0,624981	0,532359324	-5,9111E-06	1,14198E-05
ROA	-0,003291752	0,001215256	-2,70869	0,007061251	-0,005681241	-0,000902263
Dummy year	0,026215145	0,017803838	1,472444	0,14173107	-0,008791525	0,061221816

Figure 5.6: Percentage of Intangible Assets Regression

In the Ratio of intangible and total Assets model the multiple regression is performed on a sample of 387 deals. The data are obtained both from target and acquiror company (from the acquiror, as said before, the ratio of Intangible and total assets is the only metric used as regressor). Those firms are located all over the world and the data refers to the last period before the effective conclusion and announcement of the deal. All the deals occurred in the period between 1st January 2004 and 31st December 2020, the target companies belong to high tech industry and no restrictions were applied to the acquiror companies.
The model presents an F of 15,748932 and a significancy value of 3,7278E-18. The total regressors considered are 7. Among these 7 regressors 3 are statistically significant, Ratio of Intangible and total asset of acquiror company, EBIT YoY rate and ROA. Those three regressors present a significance value respectively of 4,16325E-19, 0,036222516 and 0,007061251. Those three regressors have significancy in the model, since their significancy value is below the threshold selected (0,05), and thus have influence on the share of intangible assets in the portfolio of the target company.
This model presents 3,28120692 and 0,468743846 as, respectively, Sum of squares and Main squares, this result set this model as one with higher dispersion among the models about ratios. On the other hand, the Squared R and the Adjusted Squared R are similar to the other models with 0,225333078 and 0,211025246.
This model is less variable than the R&D intensity models, this could be explained by the direct correlation between the independent variables themselves (multicollinearity) or by the complex relationship that affect the model and increase the complexity within it. The degrees of freedom are 7 for this model, showing the same pattern as the previous models.
The Intangible and total asset ratio of the acquiror company is correlated with the dependent variable with a coefficient of 0,399589871. The positive correlation indicates that the greater is the ratio of the assets held by acquiror company, the grater will be the ratio of intangible assets held by target. Another hint given by this relationship is that a potential target will pursue innovation, with patent and other kind of intangible assets, the more if there are potential target with a similar share of intangible assets in their portfolio.
EBIT YoY presents a coefficient of 0,000852015, showing a positive correlation. This relationship sounds a bit obvious because a company which is performing well has more investment power than one which is not performing as good.
The last significant regressor is ROA with a coefficient of -0,003291752, the negative correlation between the independent and the dependent variable may not be so obvious. A company with an higher return on asset will invest less in intangible assets, this is more significant for companies in early stages of their lifecycle where, once a certain level of revenues is achieved, the focus is stabilizing and improving business and cash flow. Another relevant regressor is the intercept, the value that

the dependent variable when all the other regressors are equal to zero, with a coefficient of 0,095229899. This result can suggest that there is a base value in this model that is not affected by the other independent variable-

Chapter 6

Conclusion

As a result of the analysis, all 6 models pass the F test, hereafter they're statistically significant.
The dependent variables selected are R&D expenditures and Intangible assets, both of the target firm. These variables were selected to test what was hypothesized in the study of the literature already present regarding the topic. The study was then deepened with a second set of models regarding ratios of these metrics; specifically R&D intensity, i.e., the ratio of R&D expenditures to total expenditures, and the percentage of Intangible Assets to total. Among these models only the Intangible Assets Held by target company shows less than 2 significant regressors, namely regressors which present a significancy value below the selected threshold (i.e. 0,05). This model shows that only Net Sales is the factor that influence the model and that the intercept is statistically significant too. This model has weak results at the predictive level, but being statistically significant suggests that a more in-depth study may lead to better results.
According to some writings, especially those concerning strategic choices suggest a positive correlation, while if one searches the literature more consonant with the world of M&A the result varies especially considering a possible complementarity of assets, suggesting precisely that synergy generates a value greater than the simple sum of the two values generated.
The model R&D Expenses presents as significant regressors Share price prior period (positive relationship) and Net Sales (positive relationship). This model is significant but shows some unexciting and also quite obvious results, the positive correlation with share price is the only one that can give interesting clues as it confirms, at least partially, one of the assumptions made in writing the models namely that the prospect of being acquired, and thus a good market valuation, makes target companies more active on R&D.
In any case, this model did not prove to be useless but functional in the drafting of the next 3 models.

The next 3 models are an evolution of the former, they can be thought as one since they're the same test taken in a timespan of 3 years. The first one is the R&D Intensity 3 years prior the deal announcement, which presents as significant regressors Ratio of EV and EBITDA (positive correlation), EBIT Growth rate (Negative correlation) and ROIC (Negative correlation).
The second model is R&D Intensity 2 years prior the deal announcement which presents as significant regressors again Ratio between EV and EBITDA (with positive correlation again) and EBIT yoy (again negative correlated), in this model, despite ROIC, ROA is a significant regressor (with negative correlation).
The last model is R&D Intensity a year prior the deal announcement, which presents as significant regressors again Ratio between EV and EBITDA (again with positive correlation), EBIT yoy (again with negative correlation) and ROA (with positive correlation in this model). This is the only model with a fourth significant regressor, Financial Leverage (with negative correlation).
These models always show a postive relationship with the market multiple (EV/EBITDA) which seems to suggest that a higher valuation of the company may lead to a percentage increase in R&D expenditures, this may also be due to wanting to show itself better to the market by going to increase expenditures in projects or decreasing other costs. EBIT growth (or YoY) is negatively correlated in these models, thus leading to the assessment that this increased R&D expenditure is not always repaid following the law of diminishing returns.
ROA and ROIC are also negatively correlated with R&D intensity, going to confirm when said about the ratio of intangible assets. The relationships between these regressors and the dependent variable R&D intensity find the same explanation as in the previous models, namely that once a company has succeeded in exploiting the potential of R&D spending and thus turned it into revenue, it is less likely that the management of the company will be inclined to an acquisition.
These results confirm what has been seen in the literature, a higher market multiple entices potential targets to invest even at the expense of performance measures, at the same time, however, they try to keep the debt share low to keep the deal affordable for both the target and the acquiror.
It is important to point out that this cluster of models has a pattern of improvement from the standpoint of variability, which decreases the closer the model is to the announcement date.
In addition, the improved significance value for each variable also increases the number of statistically significant independent variables.
The last model, Percentage of Intangible Assets (the ratio between intangible and total assets held by target company), presents as significant regressors percentage of intangible assets held by acquiror company (positive relationship), EBIT growth rate (positive relationship) and ROA (negative relationship). This model shows

also the significancy of the intercept. Those significant regressors give some interesting hints: the first one is the positive relationship between the percentage of intangible assets of target and acquiror company that suggests a certain degree of assets complementarity between the two companies, this type of outcome is in line with what we have seen in the literature regarding rare and difficult to imitate assets-a larger player has an incentive to gain knowledge by buying a more modest player versus spending resources on projects with uncertain output. The positive relationship with EBIT growth rate appears to be in line with the basic dynamics of the high-tech market, a greater presence of intangible assets (such as patents or licenses) is driven by a growing EBIT. The negative correlation with ROA turns out not to be obvious; conflicting views can be found in the literature regarding this performance measure, an One interpretation may be that the increase in EBIT is not such in Net Income and consequently, relative to assets, ROA decreases.
By analyzing individually the variables identified as statistically relevant, we can find net sales or EBIT growth rate that are relatively obvious and on which extensive coverage can be found in the literature.
A particular relationship common to several models on the ratios is the negative correlation between ROA with respect to both R&D and the percentage of Intangible Assets; this relationship finds different findings in the literature but can be interpreted based on the limitations of the model, in fact being the entire sample composed of deals that were successfully concluded it is reasonable to think that a high ROA could negatively influence the decision to agree to be acquired while this perspective finds a rationale in light of the complementarity with the buyer's assets or that as investment increases, if not supported by an established revenue stream, there tends to be less profit in the short run.
Focusing instead on R&D expenditures, the most comprehensive results are found in the R&D Intensity model where the dependent variable is influenced not only by firm performance measures (EBIT YoY and ROA) but also by functional metrics related to the actual deal such as EV/EBITDA and Leverage. The relationship between the intercept and the dependent variable gives us an hint about some factors that may not considered in the models or a base value that may be useful to investigate.
Overall these results partially confirm what the literature assumes and strengthen the hypotheses.
In any case, this analysis cannot be called completely exhaustive regarding the relationship between innovation and M&A, the high variability, namely the adjusted squared R, reduces the predictive power of the model but they is still valuable to widening the analysis to other statistical methods and resarches.

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