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Analysis of Biotech IPOs and underpricing changes as opposed to traditional IPOs

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Abstract

This thesis work aims to analyze in depth the peculiarities that characterize the initial public offering of a Biotech company, a world currently little explored. To do this, the focus is first on the IPO process. Subsequently, all the theories present in the literature regarding the underpricing of traditional companies are analyzed in detail. Then the focus shifts to the valuation methods of traditional companies and then to those used for biotech companies to which, due to their structural differences, traditional methods are not suitable. The thesis aims to empirically find which factors best explain the underpricing of biotech companies, starting from the theories analyzed in the theoretical chapters, related to traditional companies. In order to do so, several regression models are studied, each to thoroughly analyze a characteristic that distinguishes the biotech world. The sample illustrates 75 biotech companies that undertook the IPO process between 2017 and 2020.

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CHAPTER 1- understanding the IPO

1. A general overview of IPOs

1.1. Raising funds

Companies need to raise external funds to enable operations and invest in future growth and expansion during their life stages. Money can be raised through debt or equity. The management of a company should choose the capital structure such that the value of the company is maximized. The capital can be acquired through debt financing thanks to borrowing funds, which have to be repaid in the future. The main advantage of debt financing is that it allows a firm to leverage a small amount of money into a much larger sum. It grants a fast growth of the company. Another advantage is that, generally, debt payments are tax-deductible. The disadvantage of debt financing is that the total amount repaid exceeds the initial sum because it must pay interest to the lenders. The critical point is that debt payments must be made regardless of business revenue, which is dangerous, especially for smaller and younger firms.

Equity financing is another way to raise funds; the sale of stock generates it. The main advantage deriving from this type of funding is that funds need not be repaid. Shareholders become owners of a small stake in the company by purchasing stock. The business has to generate consistent profits to grant a healthy stock valuation and also to pay dividends. Compared to the previous financing method, debt, equity financing exposes the investor to greater risks. This is the reason why, commonly, it can be stated that the cost of equity is higher than the cost of debt, which is the interest that the lender requires.

(Adaskou, 2015) In Corporate Finance, two theories can be identified. One is the *Trade-off theory*, started by Modigliani & Miller in 1958, in which companies aim to find the optimal debt/equity ratio. To do this, they allocate resources considering both the tax benefit and the cost of bankruptcy. The optimal leverage should be found when the marginal benefit equals the marginal cost. The second theory is the *Pecking order theory*, written by Myers and Majluf in 1984, which states that companies seek funding sequentially. Firstly, they count on internal financings, such as retained earnings, and later on external ones to reduce the cost associated with asymmetric information between inside and outside investors. They choose debt primarily as external financing because by issuing

debt, they signal to investors that management is confident in the good quality of investments and that the company will fulfill its obligations. Debt financing gives the management the incentive to pursue efficient projects to avoid the risk of bankruptcy and lose the reputation and, consequently, the job.

Conversely, the issuance of equity could signal that management believes the shares are overvalued, and for this reason, it is doing the interest of existing shareholders. Therefore, it is taking advantage of the right time to raise capital, considering that the shares will suffer a price decline in the future.

(Berk & DeMarzo, Corporate Finance, 2016) explains that the optimal debt-equity ratio depends on the industry and that firms that want to decrease their effective leverage hold a large cash balance. Companies that belong to growth industries or high technology usually retain large cash and have little debt. An example can be found in the Biotechnology industry. Contrarily, sectors as automotive, real estate, oil industry typically carry high leverage.

1.2. Definition of IPO and types of offerings

The meaning of IPO is *Initial Public Offering*. An IPO is a process by which companies can sell stocks to the public for the first time[1]. The issued stock can be designated as a primary offering if the shares are new and a secondary offering if the shares already exist, resulting from the existing shareholders' participation. The IPO is an operation aimed at listing a company on the stock exchange. The offer is addressed to outside investors interested in the shares of the company. In return, the company raises funds for different purposes. In Italy, the public offer can be of two types:

- *"Offer for Sale"*: occasionally, it can happen that an IPO does not solve the need for the capital of a company entirely. To procure more funds comes in handy the OFS. The OFS is defined as an offering proposed by one or more shareholders of a company who sell all or part of the shares they own. This offer arises from the desire of one or more shareholders to divest. Therefore, it is the sale of pre-existing shares by the owners to new investors, on an exchange platform, in exchange for additional money[2].

[1] (Berk & DeMarzo, Corporate Finance, 2016)

[2] (Borsa Italiana, s.d.)

- *"Follow-on Public Offering"*: the company issues new shares, resulting from a capital increase, aimed at new potential investors. An FPO is a longer process compared to the OFS.[3]

During an IPO, OFS and FPO can be combined, resulting in the sale to the public of part of the existing shares and part of the newly issued shares.

An IPO involves many different actors, and it is time and cost consuming. Being listed on the stock exchange, on a regulated market, means that part of the company's ownership is transferred to new shareholders. Moreover, also, the related rights are transferred. Consequently, the new shareholders will be entitled to vote to decide who will take the company's lead, the Chief Executive Officer (C.E.O.). Still, they will also be allowed to approve the new distribution of dividends, which the Board of Directors must propose.

1.3. Markets

Large IPOs take place on the stock markets, defined by Duguid in 1904 as "*the mart of the world,*[4]*"* such as NYSE, NASDAQ, LSE, Borsa Italiana in Italy. (Berk & DeMarzo, Corporate Finance, 2016) The stock exchange provides liquidity and determines a market price for public companies' shares, which is not easy for private companies. Liquidity benefits investors who can, therefore, buy and sell securities quickly and easily.

For medium-sized companies wishing to go public, specialized markets offer regulatory flexibility with respect to stock exchanges. An example of it is the *Alternative Investment Market of the London Stock Exchange, AIM-LSE*. The peculiarity is that, in London's alternative investment market, instead of the underwriters, there are *nominated advisers*, who carry out the same activities as the underwriters. Also, they need to check regulatory compliance.

The alternative investment markets in France, Belgium, and the Netherlands are called *Alternext*, created in 2005. Companies wishing to be listed on Alternext must have only two years of accounting data, making the listing requirements light. Instead of the nominated advisers, there are *listing sponsors*, acting in the same way. In Italy, the specialized market to attract medium size firms is the *AIM-Italia*.

[3] (Borsa Italiana, s.d.)
(Duguid, 1904) [4]

The major stock exchanges in 2014 are shown in **Fig.1**, grouped by market capitalization and by volume of trading.

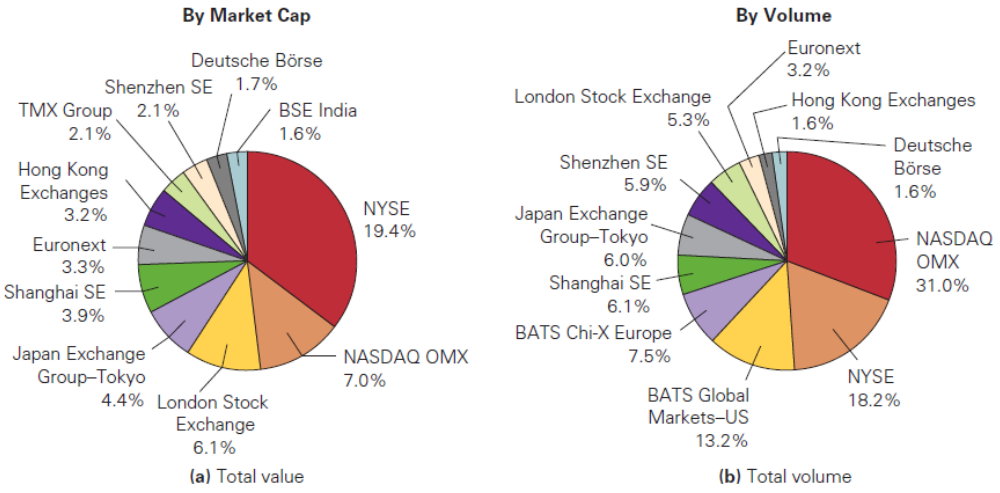

*Figure 1 – Total value by market capitalization and by volume – **Source**: DeMarzo & Berk, Corporate Finance*

The volume of IPOs is large and volatile. In **table 1** is shown the IPO activity in different exchanges. YTD 2020 takes into account the first nine months of 2020. The activity in the Asia-Pacific market is in expansion. In 2020 the activity in America already surpassed that of 2019. EMEIA (*Europe Middle East India Africa*) instead shows a contraction in IPO activity. The proceeds raised in 2020 in Asia-Pacific are 85,3 billion $, in Americas 188 billion $ and, in EMEIA 130 billion $ (EY, 2020).

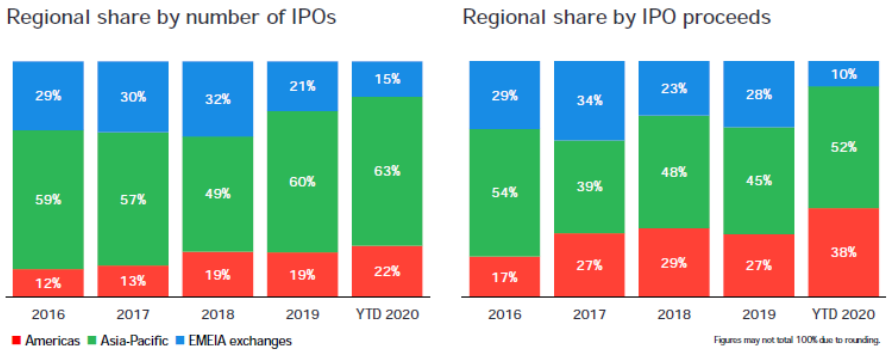

*Table 1 IPO global activity, **Source**: EY Global IPO trends: Q3 2020*

1.3.1. Sarbanes-Oxley Act of 2002

It is an American law necessary to protect investors and restore confidence in capital markets after some massive scandals have happened as Tyco International plc, Enron Corporation, and WorldCom. This act aims to reform specific areas such as corporate responsibility, increased criminal sanction (who certifies false financial data can go to jail), accounting regulation, and new protections. There are three main sections in the law:

- *Section 302* requires the financial statement to be SEC-compliant and certified by senior corporate officers. Those who declare the false can be punished with prison.
- *Section 404* instead requires internal control and reporting methods, determined by management and auditors. This section's downside is that establishing and maintaining the internal controls, essential to compliance, is expensive and affects listed companies.
- *Section 802* imposes standards on record keeping, such as the destruction and falsification of documents, the retention period for archiving documents, and archiving specific business documents.

(Jickling, 2007) It is clear that the *Sarbanes-Oxley Act* has increased the cost of compliance. For many public firms, this cost even exceeds the benefits. For this reason, after the creation of the law, many companies have switched from American stock exchanges such as NYSE and NASDAQ to AIM where compliance requirements are lighter or have started a delisting process that resulted in the creation of a private company.

1.3.2. IPO cyclicality

The next figure is essential for two reasons. Firstly, it clearly shows that IPO volume peaked during 1999-2000 due to the dot-com companies' bubble. Secondly, it shows a pattern that is repeated many times. A drop has followed the height of 2000 in the volume and proceeds. Two reasons can explain the cyclicality. The first is that when there are growth opportunities, the need for capital is greater; this reason alone can not explain the significant differences in capital needs in 2000 and 2003. The second reason is that the number of IPOs is also driven by companies and investors that in specific periods prefer IPOs to other ways of financing (Berk & DeMarzo, Corporate Finance, 2016).

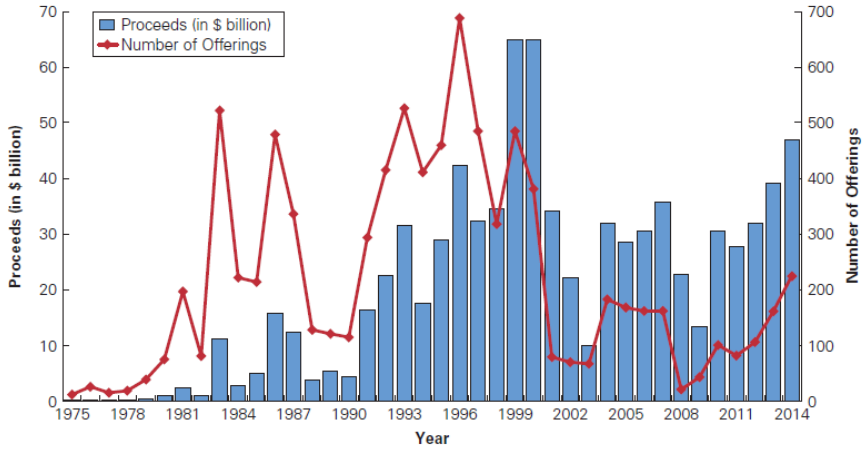

*Figure 2 – Cyclicality - **Source**: DeMarzo & Berk, Corporate Finance*

1.4. Types of investors

Investors participating in IPOs can be retail investors, thus non-institutional investors or qualified institutional buyers.

Retail investors are small individual investors. They buy and sell securities, exchange-traded funds (funds following indexes' trends and characterized by low management fees), or mutual funds (portfolio of securities) using a brokerage firm. Retail investors typically trade low amount of securities than institutional ones; their purchase power is limited. Retail investors are usually appointed as unsophisticated investors, affected the most by behavioral biases.

Robert Shiller, in his book "*Irrational Exuberance*" explains what behavioral biases are. The core theory of the efficient markets hypothesis states that individuals are rational, but this turns out not to be confirmed with the behavioral finance revolution. If rational investors' assumption holds, the market prices will self-adjust and always incorporate all the available information. *Prospect theory* postulates that people attribute a different weight to loss or gains. The major results are written in the list below:

- Investors are generally more concerned about a loss than they are happy with a gain. The idea of preferring to avoid losses rather than benefit from gains is called *loss aversion theory*. Investors can be even more willing to take significant risks to escape losses.
- Furthermore, investors have been shown to rely more on good short-term market information. They are almost indifferent to past trends; indeed, they generally do not analyze stocks' entire history. They tend to over-react to recent news. This theory is called *anchoring behavior*; prices that are similar to recent prices are called anchors. A consequence of the anchoring theory is that investors, when the market goes up, suppose it will keep going up. They become incredibly optimistic while, when the market underperforms, they become pessimistic.
- Moreover, another behavioral bias can be identified in *overconfidence*. Investors typically overestimate their knowledge and ability to value the market. They overestimate the probability of events that they identify with and want to see them happen. This is called *wishful thinking bias*.

- The last irrational behavior can be determined with the *cognitive dissonance* that refers to the mental conflicts that occur when an investor's belief is wrong. Once a decision is made, they usually identify with it and see no evidence of the contrary.

Conversely, institutional investors are large organizations that trade stocks on behalf of other people. Their trading volume is significantly higher than the volume of retail investors. Typically, they can be insurance companies, mutual funds, commercial banks endowment funds, hedge funds, or pension funds. Institutional investors are assumed to have better knowledge and resources; they are appointed as more sophisticated investors.

Bloomberg Intelligence researched retail investors' trading volume and discovered that retail investors accounted for 20% of the trading volume in 2020. The next chart shows that the trading volume of retail investors has increased over the years, **Fig. 3**.

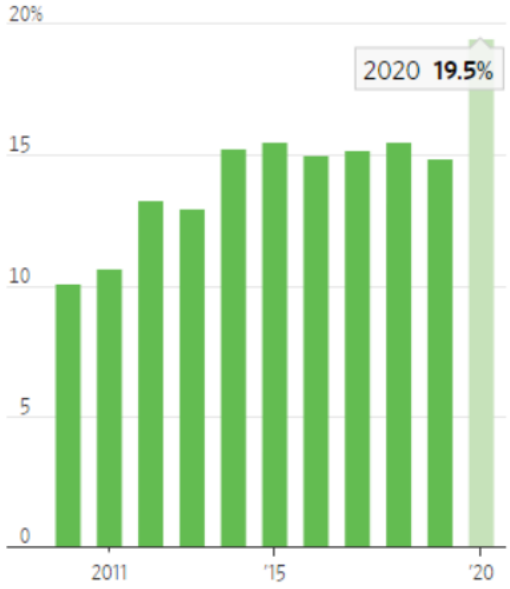

*Figure 3 – Shares' trading of retail investors – **Source**: Bloomberg Intelligence*

It is interesting to notice that retail investors nowadays are becoming more informed. This statement can be affirmed by seeing that more complex instruments such as derivatives bought have increased. Especially, retail investors buy options contracts.

Richard Repetto, the CFA of Piper Sandler, reported that the sale of single option contracts (clearly bought by retail investors, not by institutions) has doubled in a year (from 4% to 8%). This statement has been confirmed even by a research of the Deutsche Bank showing that small traders, over the years, started to buy higher volumes of options (**Fig. 4**).

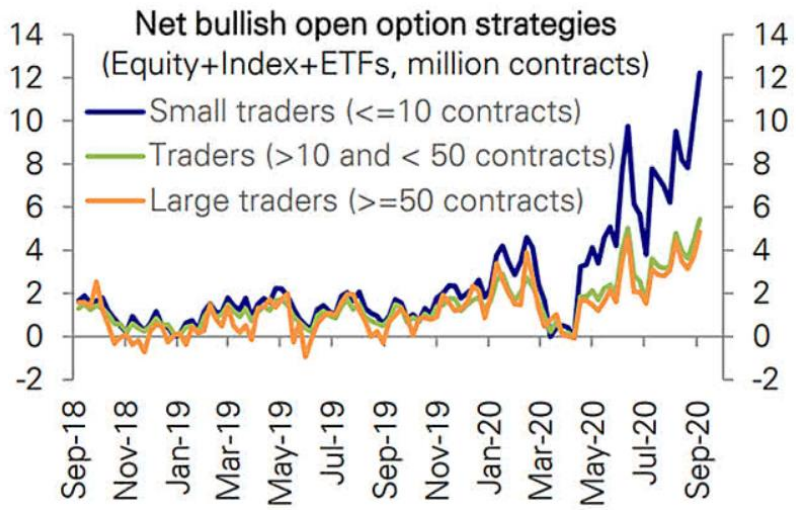

Figure 4 – Options contracts bought by retail investors – ***Source****:* Deutsche Bank *Asset Allocation*

1.5. Reasons for going public

(Pagano, Panetta, & Zingales, Why Do Companies Go Public? An Empirical Analysis, 1998) stated that going public is a decision rather than merely a stage in the life of a company. The evidence of this affirmation resides in the fact that there are many differences in IPOs' activities worldwide. To reach this conclusion, the authors noticed that many large companies aren't public in the United States of America.

Furthermore, they claimed there are countries, such as Germany and Italy, where many companies do not decide to go public and where private companies are larger than publicly traded companies. The first theory concerning the going public decision has been developed, indirectly, by Modigliani and Miller, and it discusses the research of the optimal capital structure (Brau, 2012). Modigliani and Miller's first proposition says that *any firm's market value is independent of its capital structure in a perfect capital market* (Berk & DeMarzo, Corporate Finance, 2016).

A perfect capital market must satisfy three conditions:

- investors and firms can trade the same securities at competitive market prices which are equal to the present value of their future cash flows; therefore, all the securities are fairly priced;
- There are no taxes, transaction costs, or issuance costs related to the trading;
- The financing decisions of a firm does not affect the cash flows of its projects.

Therefore, with perfect capital markets, the financing method has no impact on the company's value. The capital structure is not relevant because every combination of debt and equity is optimal.

A firm with outstanding debt is called a *levered firm,* while a company financed only with equity is named an *unlevered firm*. The leverage of a firm is defined as the ratio between debt and equity.

The second proposition of Modigliani & Miller says that *the cost of capital of the levered equity increases with the firm's market value debt-equity ratio*.

$$r_E = r_U + \frac{D}{E}(r_U - r_D)$$

Equation 1 – M&M proposition II

In the previous equation r_E is the expected return on levered equity, which is the cost of the equity capital, r_U is the expected return on unlevered equity, r_D is the expected return on debt, so it is the cost of debt. This equation implies that the greater the leverage, the higher the expected return on levered equity. Debt itself is less risky than equity, so it is cheaper than equity, but it increases the cost of equity because levered equity is riskier than the unlevered one. In this context of perfect capital markets, the advantage of the lower cost of capital, obtained through financial leverage, is offset by the increased risk and cost of equity. To conclude, the consequence of the second proposition is that *the company's cost of capital, r_{wacc}, remains the same. It doesn't depend on the capital structure; it equals the equity cost of the unlevered firm's capital and the cost of capital of assets.*

$$r_{wacc} = r_A = r_U = \frac{E}{V}r_E + \frac{D}{V}r_D$$

Equation 2 – Consequence of M&M II

Where V is the value of the company, and it equals the sum of debt and equity.

Instead, the third proposition of Modigliani & Miller states that *a company should be 100% financed with debt if that company pays corporate taxes* because interest expense is tax-deductible. The proposition says that*, in the presence of corporate taxes, the firm's value increases linearly with the level of debt D*. For this reason, an increase in leverage increases the income available to all investors. The interest tax shield, computed as the product of the corporate tax rate times the interest payments, is the benefit that is achieved by investors. The conclusion is that the firm's cost of capital, the r_{wacc}, decreases if the only

market imperfections are the corporate taxes. The optimal capital structure with corporate taxes is obtained when the level of leverage has an interest that matches the EBIT (earnings before interest and taxes).

A firm is said to be in *financial distress* when it faces trouble in meeting its debt obligation. When it cannot repay its debt, the firm is in *default*—the greater the firm's leverage, the greater the possibility of bankruptcy. Bankruptcy implies direct costs and indirect costs, which can be substantial, and it is the natural consequence of leverage. The trade-off theory tries to identify the optimal capital structure, weighting both the advantage of using debt due to the tax shield and the bankruptcy costs.

The theory says that *the total value of a levered firm equals the firm's value without leverage plus the present value of the tax savings from debt, less the present value of financial distress costs* [5]. The optimal leverage minimizes the WACC and maximizes the value of firms.

In conclusion, the first theory evinced that managers decide to issue equity when the IPO proceeds decrease the cost of capital. Generally, IPO firms encounter a lower cost of capital after the IPO. This phenomenon, together with the increased visibility after an IPO and the access to more massive amounts of money through public markets, grants a higher bargaining power to firms with banks (Brau, 2012). The bargaining power of a company with banks increases with an IPO because accessing the stock market means creating outside competition to the lenders. This, in turn, ensures a lower cost of credit (Pagano, Panetta, & Zingales, Why Do Companies Go Public? An Empirical Analysis, 1998).

In the literature, many models capture a single aspect of the going public decision, which can be either costs or benefits[6]. The principal already existing models, associated with going public costs and benefits, are summarized in the following tables. The first table focuses on the costs related to going public and, implicitly, the reasons for remaining a private company:

Cost	Model	Prediction
1. Adverse selection and moral hazard	Leland and Pyle (1977),	The first aspect that convinces firms to remain private is the so-called adverse selection, resulting from the informational asymmetry. The latter derives from the fact that outsiders know simply less than insiders. The

[5] (Berk & DeMarzo, Corporate Finance, 2016)
[6] (Pagano, Panetta, & Zingales, Why Do Companies Go Public? An Empirical Analysis, 1998)

	Chemmanur and Fulghieri (1995)	informational asymmetry might influence the quality of the firms that will be listed on the stock exchange. Many theories show that IPO pricing and, consequently, the underpricing phenomenon is due to asymmetric information. Both informed and uninformed investors participate in IPOs. Uninformed investors bid without considering the quality of the IPO, while informed ones bid only on companies from which they can get a higher return. The majority of investors are uninformed, so it is necessary for the underwriters that uninformed investors participate in IPOs and bid. Underwriters, to attract this part of investors, lower the price. The evidence shows that underpricing is lower when underwriters can allocate stock primarily to informed investors. In this case, it will, therefore, not be necessary to significantly lower the price (Solomon, 2011). Thus, the more the asymmetric information, the more the underpricing, which is a cost for the issuing company. Also, the likelihood of going public for a company increases with its size and age. Due to asymmetric information, investors are reluctant to buy shares of a young company with a limited track record. The older and the bigger the firm, the higher the probability of going public. Generally, investors perceive a high profitability firm as an excellent quality firm leading to an overvaluation of its shares. This allows firms to overcome the problems of adverse selection and be able to go public. The theory of asymmetric information is confirmed by the *pecking order theory*, which states that issuing equity might signal that shares are overvalued due to managers' impossibility of first getting financed with internal sources of finance as retained earnings, secondly, with debt.
2. Fixed costs	Ritter (1979)	The likelihood of a firm going public increases with its size because most of the firm's going public costs are not proportional to size, so typically, a small firm can not afford

		them. This leads to a higher probability of going public for bigger companies.
3. Loss of confidentiality	Campbell (1979), Yosha (1995)	To go public, a company is forced to unveil private information that could affect its competitive advantage and the results of its R&D. Going public means increasing the transparency and decreasing the possibility of tax elusion due to close control of the tax authority. The probability of going public decreases for companies with sensitive data to protect, so the higher the R&D, the lower the likelihood of going public.

Table 2 – Literature theories to stay private

The following table focuses on the benefits associated with the "go public" decision.

Benefit	Model	Prediction
1. Overcome borrowing constraints		One of the significant advantages that the literature analyzes and that pushes companies to go public is financing themselves with other sources rather than with banks, thus overcoming the debt constraint. Highly levered firms can face many difficulties in raising additional money using debt due to increased risk that creditors do not want to bear. As mentioned above, the direct consequence of an increase in debt is an increase in bankruptcy risk. Thus, the probability of a firm to go public should increase for highly leveraged companies. Contrary to the expectations, Pagano[7] discovered that leverage and the likelihood of an IPO negatively correlate. He noticed that levered companies that went public could have trouble to find investors because they may be skeptical due to the high debt level. This phenomenon can be seen as a deterrent to going public.
2. Diversification	Pagano (1993)	In the literature, another reason pushing firms to go public is the owners' willingness to diversify their wealth—the incentive of the owner to diversify increases with the size of its stake in the stocks. The diversification can be

[7] (Pagano, Panetta, & Zingales, Why Do Companies Go Public? An Empirical Analysis, 1998)

		achieved either by divesting in the old assets and investing in new ones or simply through the rise of new equity. Thus, when a company goes public, the possibility for the owner of diversification is higher. Pagano[8] also noticed that the firms wishing to diversify are especially companies in high-risk sectors. The level of intangible assets can be used in assessing the risk. The authors experienced a positive correlation between the presence of intangible assets and the likelihood of IPOs.
3. Liquidity	Market microstructure models	Private companies can sell shares by contact investors through brokers. The process is time-consuming and expensive due to transaction costs. The transaction costs can be reduced by the sale of shares on the stock exchange. Being listed on a stock exchange increases the liquidity of the companies' shares—the liquidity of a firm's shares increases when the shares trading volume increases. Therefore, liquidity benefits should be higher for larger companies. IPO can also allow insiders to cash-out by selling their secondary shares in the IPO process (Brau, 2012).
4. Stock and market monitoring	Holmstrom and Tirole (1998), Pagano and Roell (1998)	After an IPO, executives' control becomes stricter, and managers' decisions become more transparent (Brau, 2012). A public company is a company where the managers' compensation scheme is easier to be defined and more efficient. It can be made by looking at the share prices (there are two prevailing methods: managers' wage can be indexed to the stock price, or managers can be remunerated with stock options). In addition, private companies can be over-monitored. This is costly. Therefore, a private company wishing to grow and needing financing will decide to go public. In conclusion, the probability of going public increases the

[8] (Pagano, Panetta, & Zingales, Why Do Companies Go Public? An Empirical Analysis, 1998)

		higher the number of future investments planned of a private firm.
5. Enlarge set of potential investors	Merton (1987)	This theory explains how going public can be a powerful advertising medium for the company. It helps companies to increase their visibilities. The listing brings numerous benefits to investors and brings greater transparency within and outside the company, increasing its reputation. Investors can better monitor the company's share price, allowing them to become more informed. Investors tend to be more aware of public companies' stocks rather than shares issued by private companies. The higher the number of investors aware of the shares, the higher the share price. The theory states that the more considerable benefit should be captured by sectors having a large customer base as the retail trade sector. Theoretically, companies belonging to that sector should be more incentivized to go public (Noguer & Pope, 2004).
7. Optimal way to transfer control	Zingales (1995a),	When the owner wants to sell his company, he would be willing to use an IPO to maximize his selling proceeds. To do so, he must achieve the right structure of ownership. The owner would extract more surplus from the buyer due to the cash flow increase by selling cash flow rights to disperse the shareholders while maintaining control. A benefit deriving from the IPO process is to have the company priced. This allows the target firm to be easily bought after establishing the market price (Noguer & Pope, 2004). IPOs allow the creation of public shares, as a sort of currency, that can be used to buy other companies or to be bought in stock deals (Brau, 2012).
8. Exploit mispricing	Ritter (1991)	The higher the firms' overvaluation in a sector, the higher the probability of companies in that sector to go public. This theory is denominated as the "exploitation of the window of opportunity" or "the hot issue markets

		anomaly." Theoretically, there should be a positive relationship between the industry market-to-book ratio, which is a measure of the sector's buoyancy and the likelihood of an IPO. Pagano[9] has demonstrated it by noticing that, after the IPO, over-priced IPO firms' profitability and investments decreased over time. Moreover, indirect evidence of the exploitation of the so-called window of opportunity derives from the underpricing phenomenon. Over-priced IPOs generally face a first-day underpricing because of the high demand.

Table 3 - Literature theories to go public

(Noguer & Pope, 2004) built an econometric model on understanding each factor's impact, deriving from the previously discussed theories, on the likelihood of IPO. The sample comprises newly public firms listed on the London stock exchange and the Alternative Investment Market, while the private firms are extrapolated from the financial database called FAME (it is a database collecting private and public firms resident in Ireland and UK). The regression equation follows:

$$IPO_{it} = \alpha_0 + \alpha_1\, SIZE_{it} + \alpha_2\, CAPEX_{it} + \alpha_3\, GROWTH_{it} + \alpha_4\, LEVERAGE_{it} + \alpha_5\, PROFIT_{it} + \alpha_6\, MEDIANMTB_{it} + \alpha_7\, INTANG_{it} + \alpha_8\, RETAIL_{it} + \alpha_9\, YR2 + \cdots + \alpha_{9+N-1}\, YRN$$

*Equation 3 – Regression line - **Source**: Noguer & Pope, The determinants of the going public decision: evidence from the UK*

The dependent IPO variable can assume only two values, 0 if the firm is private while one if it went public that year t. The IPO variable can be explained using many predictors listed above (such as size, capex, growth etc…). N is the number of years that the sample covers., The SIZE predictor is measured by the logarithm of total assets (LOGTA) and by the logarithm of sales (LOGSALES). Following the previously discussed theories their relations with the IPO variable should be positive. Investment opportunities are captured by the CAPEX predictor (calculated as $\frac{Capital\ Expenditure}{Total\ Assets}$) and by GROWTH (measured by $\frac{Sales_t - Sales_{t-1}}{Sales_{t-1}}$). Also, according to theory, the relation between CAPEX and GROWTH

[9] (Pagano, Panetta, & Zingales, Why Do Companies Go Public? An Empirical Analysis, 1998)

with IPO should be positive, implying that firms go public to raise finance to grow and invest.

Besides, the relation with MTB ratio should be positive as well, following the prediction of the exploitation of the window of opportunity by firms, in periods of overvaluations. The MTB predictors has been calculated as $\frac{Market\ Capitalization_t}{Equity\ book\ value}$.

The predictor INTANGIBLE is used as to account for the risk of a firm. It has been calculated as $\frac{Total\ intangible\ assets}{Total\ assets}$. Its relation should be positive, too, according to the diversification theory.

The predictor RETAIL wants to test if the company belongs to the trade industry because it is assumed to have a more extensive customer base.

Two relations can not be considered positive or negative a priori; in fact, LEVERAGE could be positively or negatively correlated to the likelihood of IPOs, due to the difficulty of increasing the debt as a financing method. The consequence is that, if firms have a high debt level, they should go public to get additional funds. Leverage is calculates as $\frac{Total\ debt}{Total\ assets}$. PROFIT instead tests firms' profitability, and can be calculated as $\frac{EBITDA}{Total\ assets}$ or as $\frac{\text{Operating profit}}{Total\ assets}$; the relation with the probability of going public can not be understood a priori either. Following the pecking order theory, profitable firms may prefer internal financing rather than the external one and avoid the dispersion of ownership, which usually causes higher costs, assuming the relation as negative. Still, on the other hand, profitability can overcome adverse selection, ending in a positive correlation.

Results of the empirical evidence are shown below:

VARIABLE	Model 1		Model 2		Model 3		Model 4	
	α	*Odds*[1]	*α*	*Odds*[1]	*α*	*Odds*[1]	*α*	*Odds*[1]
INTERCEPT	-10.80***	-	-6.33***	-	-10.10***	-	-6.27***	-
LOGTA	0.743***	*(2,481)*	-	-	0.669***	*(2.306)*	-	-
LOGSALES	-	-	0.263***	*(1.446)*	-	-	0.267***	*(1.508)*
CAPEX	0.0009	*(1.008)*	0.0015	*(1.014)*	0.0026*	*(1.031)*	0.0030*	*(1.035)*
GROWTH	0.0012	*(1.029)*	0.0011	*(1.027)*	0.0009	*(1.023)*	0.0008	*(1.021)*
LEVERAGE	-2.505***	*(0.153)*	-2.437***	*(0.161)*	-2.600***	*(0.140)*	-2.548***	*(0.145)*
EBITDA/TA	-1.996***	*(0.718)*	-1.679***	*(0.757)*	-	-	-	-
OPPR/TA	-	-	-	-	-0.200***	*(0.946)*	-0.125**	*(0.966)*
MEDIANMTB	0.468***	*(1.658)*	0.439***	*(1.606)*	0.486***	*(1.694)*	0.447***	*(1.624)*
INTANG	0.208***	*(1.517)*	0.285***	*(1.768)*	0.193***	*(1.471)*	0.246***	*(1.636)*
RETAIL	0.319***	*(1.892)*	0.220**	*(1.551)*	0.282***	*(1.758)*	0.214***	*(1.533)*
IPO = 1	450		449		603		602	
IPO = 0	37,497		37,489		39,636		39,619	
% Concordant	84.3		77.4		83.6		76.9	
Nagelkerke R^2	20.43%		12.09%		18.24%		11%	

Notes:
[1] Odds ratios disclosed represent the increase in the odds (i.e. the probability of going public over the probability of remaining private) when the correspondent independent variable increases by one time its standard deviation, except for the dummy variables INTANG and RETAIL where they represent the increase in the odds when the variable changes from 0 to 1.
All the models are estimated including calendar year dummy variables, for which coefficients are not reported.
**p <0.1, **p < 0.05, ***p < 0.01.*

Table 4 regression models – Source: Noguer & Pope, The determinants of the going public decision: evidence from the UK

In this analysis, four models have been used: to test the importance of size, models 1 and 3 use the logarithm of total assets, while models 2 and 4 use the logarithm of sales. Moreover, to test profitability, model 1 and 2 consider EBITDA over total assets, while models 3 and 4 the operating profit over total assets. In the table the odds ratio is reported which represents the increase of the probability of going public over the likelihood of remaining private when the independent variable increases by one standard deviation and, in the case of dummy variables (as INTANG and RETAIL), when the variable shifts from 0 to 1.

The odds ratio should not be confused with the probability because it is calculated from the probability. The odds ratio is calculates as $\frac{p_{event}}{1-p_{event}}$. The odds ratio measures how much the occurrence of an event in a group is more likely with respect to the occurrence in the other group. The ratio measures the strength of the relation between the dependent variable and the independent variable. No relation corresponds to the odd ratio equal to one.

The authors empirically demonstrated that the most important determinants of an IPO are:

- the size of a firm (in fact, it is highly significant and an increase in the logarithm of assets increases the odds of 2,48 in model 1 and 2,3 in model 3) implying that bigger size firms have 2,48 times the probability of going public with respect to lower size firms;
- the industry market-to-book ratio. An increase of a deviation standard in the median industry market to book ratio raises the odds of 1,69 in model 3, and in the other models, by more than 1,6.

Thus, the probability of going public raises mainly for larger firms having more data available to reduce the adverse selection and that can sustain the cost of the IPO process, and with the increase in the stock market valuation of the companies which belong to the same market.

Regarding the investments, from the analysis, it can be stated that it is partially a reason to go public but not a major one. As a matter of fact, GROWTH is not significant at all, while CAPEX is significant only in models 3 and 4. Moreover, the odds are close to one.

Returning to the relation with predictors that did not have a clear sign a priori, in theory, it can be expressed that LEVERAGE is highly significant and negatively correlated with the probability of IPOs. Consequently, a reason for firms to go public cannot be identified in the presence of high leverage, which is, instead, a deterrent. Profitability measured by EBITDA/TA and OPPR/TA is negatively related to the probability of going public as well.

RETAIL confirmed the prediction that sectors having a more extensive customer base are more willing to go public; in fact, the predictor is positively related to the probability of going public.

As far as the INTANG predictor is concerned, a positive relationship has been found; however the sample of firms is extrapolated in a high-risk period, in the 1990s; hence, it can be affected by the dot com wave. For this reason, further analysis must be carried out to confirm the result.

1.6. The IPO process

(Ghosh, 2002) It is expected behavior for a firm that wishes to undertake an IPO to start acting as it is a public company, already in the two years that precedes the IPO. A private company must be ready on time. The key to the success of an IPO is market timing. For this reason, it happens that in periods in which the market is not favorable, IPOs are postponed or canceled because of the short interest that the process can arouse in investors, causing a low volume of sales. Companies' strategy to be ready to go public is standardized and can be represented in five successive stages.

1.6.1. Steps to follow

The first step is the team selection (underwriters, legal team, public accountant etc…), then the team will be devoted to write the prospectus and submit it to the SEC to receive the approval. The third stage is represented by the company's presentation to

investors, especially institutional ones, in the so-called "*Roadshow*" by the issuing company and the underwriters. The pricing and the declaration of how many shares will be issued are also the most complicated task. The last stage is the development of the aftermarket position.

1.6.2. Team selection

The selection of the right team is an operation that generally requires a lot of time. The team must include an underwriter, typically an investment bank, a law company, and a public accountant. (Berk & DeMarzo, Corporate Finance, 2016) Depending on the size of the IPO, the underwriter can be alone, called the *sole managed*, or there can be many underwriters directed by the *lead underwriter,* a banking firm responsible for managing the deal, often called *the book-running manager*. Underwriters are chosen based on their reputation and their experts' quality in the sector they belong to. The group of underwriters is named *the syndicate*. Each of the underwriters that are part of the syndicate will be responsible for selling a percentage of shares. The syndicate members are chosen based on strategic alliances such as the distribution of their client base nationwide or worldwide. The ten largest underwriters undertook more than 50% of IPOs in the United States in 2014, as shown in the next table:

	2014		
Manager	Proceeds ($ billion)	Market Share	No. of Issues
Morgan Stanley	22.19	8.9%	130
Goldman Sachs	21.32	8.6%	114
JPMorgan	17.67	7.1%	126
Deutsche Bank	17.35	7.0%	95
Credit Suisse	16.19	6.5%	113
Citi	14.68	5.8%	96
UBS	11.02	4.4%	86
Bank of America Merrill Lynch	10.23	4.1%	88
Barclays Capital	7.41	3.0%	76
HSBC Holdings	6.12	2.5%	23
Top 10 Totals	144.18	57.9%	947
Industry Totals	249.02	100.0%	1205

*Table 5 – Largest underwriter – **Source**: DeMarzo & Berk, Corporate Finance*

1.6.3. Agreements

Several types of agreements among the underwriter and the firm can be selected, depending on the IPO size. The initial one is called a *letter of intent*. Smaller IPOs can be managed using a "*best-effort*" contract in which the underwriter has the duty to try to sell the shares at the best price it can achieve. In this contract, the underwriter does not grant

the success of the deal. For this reason, this type of agreement may include a clause called "*all or none*" which implies the two directions the deal can follow, or the underwriter sells the right number of agreed shares, or the contract falls apart. The most adopted agreement is "*firm commitment*." The difference with respect to the previous type is that the underwriter grants the sale's success. The underwriter agrees to sell the predetermined number of shares at the IPO price. Firstly, the underwriter buys all the firm's shares at a discount and will then be responsible for the public's sale. Noticeably, the risk is on the underwriter. Indeed, the contract must include a "*reimbursement*" clause to protect the underwriter of the expenses incurred even in the event the IPO is withdrawn at any stage of the process. Generally, in larger IPOs, it is challenging for the lead underwriter to manage the whole process independently. It prefers to diversify the risk and spread it over a group of underwriters, the syndicate.

Moreover, the agreement must include the discount at which the underwriter buys shares from the issuing company, generally the 7% of the proceeds, and the overallotment option. A seven percent discount is considered a large fee because there is also the underpricing cost to consider. Indeed, there is a theory in the literature, proposed by Chen and Ritter, which states the possibility of implicit collusion among the underwriters. A later view, by Robert Hansen, contradicts it, expressing that lower fees to the underwriters could signal a lower quality of the investment bank compared to its competitors. In support of this theory, Craig Dunbar empirically detected that market share increases with a slight reduction in fees. In contrast, market share decreases dramatically for low commissions.

In the *letter of intent,* there must also be a section in which the issuing company declares its intention to co-operate using due-diligence with the underwriter and take responsibility for disclosing all the relevant information.

1.6.4. A preliminary and final prospectus

The team's first meeting is called the "*all-hands*" session, and its primary responsibility is the allocation of duties to the members following a timeline. It generally takes place from six to eight weeks prior that the company registers with the SEC. After the first meeting, the team will be busy drafting the prospectus to provide investors reliable information about the company. For filing with the SEC, the team with managers must prepare a registration statement, called the *S-1 form*, according to the Securities Act of 1933, to provide investors with the necessary information before the process occurs. Once

completed, the registration statement will be converted into a preliminary prospectus, often called the "*Red Herring*." The prospectus includes:

- Five years of financial data;
- Description of the management team;
- Description of the firm, the competitors, and more importantly, the growth strategy;
- The range for the possible IPO price.

When the SEC receives the registration statement, it checks that the information has been disclosed and can either approve it or reject it. After that, a company filed, the SEC concedes a quiet period that generally lasts 25 days from the day in which stocks began to be traded. Once the SEC has approved the registration statement, the company and the team have to edit the final registration and the final prospectus.

In conclusion, the preliminary prospectus is different from the final one. The first is just the official announcement that the company will go public, including information such as the underwriters' names and the types of shares to be issued. It is the first document prepared. After months, the underwriter has gathered more information and will prepare the final one, including the shares' price and the number of shares to be offered.

1.6.5. Roadshow

When the SEC approved the prospectus, the issuing company's executives, as the CEO and CFO, and the underwriter can start the Roadshow. It is a travel that can last up to four weeks in which the group presents the company prospect and the IPO potential in advance. Usually, the meeting is addressed mainly to institutional investors such as pension and mutual funds. American firms have two sessions per day and travel countrywide in cities like New York, Los Angeles, San Francisco, Boston, and Chicago. Still, the Roadshow can also include foreign cities as Paris, London, Tokyo, etc.

For a marketing purpose, it is imperative the Roadshow and how the company is presented to investors. It is a crucial stage to reach a successful IPO and to set the right issue price.

(Reuters, 2020) During 2020, the year of the Covid19 pandemic, the way the Roadshow takes place has transformed. The big cities' trip to present the offer has become virtual due to the impositions related to social distancing.

(Reuters, 2020) The most significant IPO since the pandemic started in 2020 has been Warner Music Group. Thanks to the virtual Roadshow, the management has met all the

potential investors online and concludes the Roadshow in only four days. Financial markets are very volatile nowadays, so doing a short roadshow has prevented uncertainty deriving from volatility. The group's Chief Executive expressed the key to the IPO's success, the right market timing. In any case, there are many concerns about how it would be possible for young firms and startups to attract new investors only virtually.

During the Roadshow, the lead underwriter collects all the investors' demands and keeps them in a book. When the Roadshow closes, the managers and the underwriters meet once again to establish the final offering price with the corresponding number of issuing shares, based on the demand derived by investors at the Roadshow.

1.6.6. Price setting

1.6.6.1. Book-building

This process of setting the price is called *book-building.* Firstly, the lead underwriter has to choose which institutional investors will be asked to participate. Later, the underwriter collects non-binding bids from investors, which can be of two types:

- *Strike bid*, in which the investor is willing to buy, for any price included in the price range, a certain number of shares;
- *Limit bid*, in which the investor proposes a price and the respective quantity of shares he would like to purchase;

The last stage of the book-building process is the final price setting, a few days before the IPO takes place and the shares allocation to investors, at the underwriter's discretion. To set the price, the underwriter has to carefully balance the company's interests that want to raise as much money it can, and the investors' interests, wishing to conclude a bargain, seeing an increase in the share price after the purchase. Typically, the underwriter would set a price such as the appreciation on the first day is of 15%. The book building is the first method for assessing the price and also the most preferred one.

1.6.6.2. Fixed-price

Besides the book-building, there are two other pricing methods: the fixed price and the IPO auction that differs in how demand and supply are matched. The second method is the fixed price, where the company and the underwriter hold a meeting and share the information in their possession. Subsequently, the underwriter decides a fixed price at which to sell the shares. The actor who bears the risk is the underwriter. Market demand will remain unknown until the matter is closed.

The company tells the investment bank the exact number of shares it wants to sell. The supply is, therefore, rigid. The underwriter starts selling the shares; it can run into two different situations. High demand, leading to over-subscription or low demand, resulting in under-subscription. If demand is low, the underwriter will have to buy the difference between the company's number of shares and those already sold.

For this reason, it will have a strong incentive to lower the issue price to reduce the probability of incurring under-subscription. Another factor affecting this pricing method is that the underwriter will not discriminate against investors and reward loyal clients. The shares will be allocated to investors with a lottery or pro-rata. On the one hand, if the over-subscription is low, the shares can be allotted on a pro-rata basis. In this case, each investor is assigned a lot of shares. The remaining lots will be awarded to investors in proportion to the number of lots they were willing to buy. If the oversubscription is high, on the other hand, the system used to provide shares to investors is the lottery.

1.6.6.3. IPO Auction

The last pricing method is the IPO auction. In an IPO auction, investors place bids for a certain number of shares they wish the buy and the related price they want to buy the stocks. The underwriter acts as the auctioneer and collects the binding bids. In this auction, the seller, which can be either the issuing firm or the underwriter, begins to ask high prices for which no investor will accept the deal. The auctioneer periodically decreases the price until investors are welcome to buy a certain quantity, and the auction closes when the bids collected equals the offer quantity. Thus, the final price is the one that covers the whole offer quantity. All the shares will be allocated, starting from investors who bid the highest price and sells at the market-clearing price. This auction is called a *descending price auction or Dutch auction*, with a uniform price, meaning that the IPO price is such that the demand matches the supply. All the investors pay the same uniform price; IPO auction encourages aggressive bidding because investors are protected from bidding a too high price. The supply is fixed, and the firm decides it while the demand derives from the binding bids.

This way of pricing the IPO shares is, first of all, fair due to the fact that all investors pay the same price and that the market determines the price. One of the main advantages of the auction is that it is less expensive than the book-building due to lower underwriter's fees. Theoretically, there should not be underpricing in this method because all the investors wishing to purchase shares at a higher or at least the same price as the IPO price will get

the shares. Another benefit of this way of setting the price is that small investors also participate in the auction. Indeed, the other methods are managed by the underwriters that will favor institutional investors.

There are also disadvantages concerning the Dutch auction. The first one is that the valuation might be less precise than an underwriter's valuation due to small investors' lack of experience in evaluating shares. It is assumed that all investors are rational; they should value stocks equally. The security has a unique value. Conversely, investors can have different information about the IPO leading to different evaluations. This is a situation of asymmetric information. The consequence is that the winning bid can overestimate the shares' real value, paying more shares that are worth less. Hence, winning brings with it bad news called *the winner's curse* (Adam, Eidels, Lux, & Teubne, 2017). Retail investors, who are supposed to be uninformed, could end up with few stocks in good IPOs and many stocks in bad IPOs. On the other hand, underwriters may favor institutional investors that are unwilling to bid on IPOs they feel are not worthwhile. Moreover, generally, multi-units auctions entail the phenomenon of demand reduction. Investors who want to purchase multiple units have an incentive to strategically lower the demand price so that, in case of a win, that quantity they bid will be the one that clears the supply, and investors pay less. If the supply is rigid, the auction can lead to the achievement of low prices. The demand reduction theory has been proved by Kagel and Levin in 2001.

To conclude, in principle, Dutch IPO auctions should not have underpricing. Due to the strategic bidding behaviors deriving from the demand reduction and the winner's curse, in reality, they have.

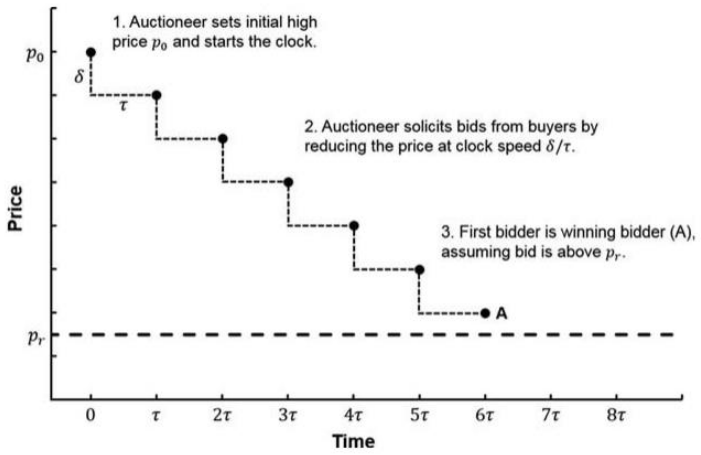

*Figure 5 – Dutch auction - **Source**: Adam, Eidels, Lux, & Teubne , Bidding Behavior in Dutch Auctions: Insights from a Structured Literature Review*

A modification of the Ducth Auction called Open IPO Auction deploys a mathematical algorithm to allocate the shares impartially to bidders. Every investor will pay the same price. This auction is private. Morningstar Inc., for example, used an OPEN IPO auction to go public. OPEN IPO is mostly used by the investment bank WR Hambrecht + Co[10], based in San Francisco (WR Hambrecht + Co, s.d.).

1.6.7. Managing the aftermarket risk

After starting an IPO, there are twenty-five days that, in July 2002, were extended to forty days by SEC, called the *quiet period*. After that period, the underwriter can furnish future earnings forecasting and comment on the IPO. This stage of the process is essential to stabilize the aftermarket price, therefore to manage the aftermarket risk so the risk that the share price may collapse. There are three ways the underwriter will try to achieve stabilization. The first mechanism is called "*pure stabilization*"; if there are still shares to be sold, the underwriter sets a stabilizing price that can not exceed the issue price. Another mechanism to manage the aftermarket risk is the sale of more shares. Generally, 15% more than the issue's size, called *greenshoe provision* or *over-allotment allocation*, at the issue price; The underwriter borrows the allotment shares from the issuer and sells them to the investors when the IPO is concluded. This mechanism is called short selling because the investment bank does not own the additional shares. The offer can be hot, if successful, or cold, if unsuccessful. In the first case, the price increases, the underwriter buys the shares from the issuing company at the IPO price minus a discount, earning the discount. Instead, if the issue is a cold offer, the underwriter repurchases the shares from the open market allowing the price support. The last instrument regards *penalization*; indeed, the underwriter may also penalize the investment bank with investors who are used to "flip" shares. This is how investors buy shares at the IPO price and then sell them a few days after, taking advantage of underpricing, to earn a fast profit. The investment bank can then decide to pass the penalty to its client.

When an IPO is concluded, the newly listed company's shares can be publicly traded on a stock exchange. The underwriter's next task is an analyst's assignment to cover the stock market to increase the liquidity of the shares in the secondary market. This process benefits both the listed company, which has continuous access to the stock market, facilitating the subsequent issue of shares and investors who can freely trade the shares. A

[10] WR Hambrecht + Co is an investment bank residing in San Francisco which is highly specialized in OPENIpo.

180-day period is called a "*lockup*," during which company insiders can not sell their shares. This is an incentive for them to work hard to get the share price to rise, avoiding cashing out if there are negative market news.

1.7. Underpricing

(Borsa italiana, s.d.) Underpricing is a tremendous indirect cost of IPOs. It means "money left on the table" for the issuing company. Underpricing is the practice whereby the fixed issue price is lower than the market value of the securities at the time of issuance and is represented by the following formula:

$$Underpricing = \frac{P\ end\ first\ day\ of\ trading - P\ issue}{P\ issue}$$

If the company and the underwriter's agreement is a *firm commitment*, the risk is on the underwriter. The shares could be sold at a lower price than the IPO price, incurring a loss. To offset the risk, the underwriter will have an incentive to reduce the price after having forecasted the demand through the Roadshow. Professor Jay Ritter showed that (Berk & DeMarzo, Corporate Finance, 2016):

- only nine percent of companies experience a price drop on their first trading day;
- the 16% of IPOs experience a stable price the first day of trading with respect to the IPO price;
- the majority of IPOs incur a rise in the share price.

The benefit of underpricing is captured by investors able to buy stocks from underwriters at the IPO price. Instead, the cost is borne by the issuing firms' pre-IPO shareholders because they could achieve a higher gain in the aftermarket. (Berk & DeMarzo, Corporate Finance, 2016).

1.8. Costs of going public and being public

(Strategy& PwC, 2020) Every IPO is associated with high complexity, time, and costs (related to both going and being public) that normally, companies underestimate. To overcome uncertainty about future costs, companies should employ project management resources to:

- help companies in managing the entire IPO process;
- allocate the right resources to each activity (considering the time to devote to each activity and the related cost) to allow each activity to be in line with its delivery.

The process requires creating an *IPO plan* by an internal employee or an IPO advisor and monitoring the progress to meet the deadlines. This is a way to better predict and analyze all the costs they will incur during and after the IPO process. The latter entails the cost of transforming the infrastructure of a private company into a public one but also maintaining it. Nowadays, only 19% of companies hire a third party to produce the so-called *IPO readiness assessment*[11] shown in **Fig. 6**:

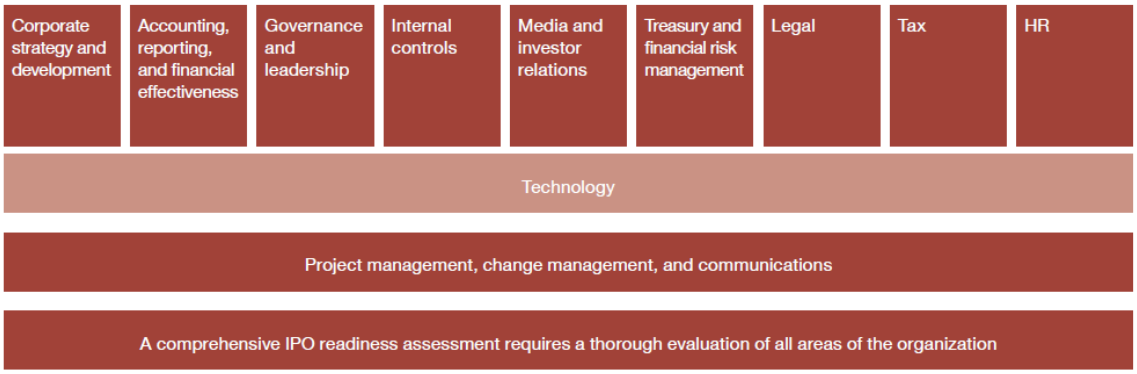

Figure 6 - IPO readiness framework – ***Source:*** Strategy& PwC, Considering an IPO? The costs of going and being public may surprise you.

During the IPO process, generally, companies engage external resources such as *securities counsel* to manage the underwriters' relationship and receive legal advice to better deal with the SEC.

1.8.1. Costs of going public

Going public consists of numerous steps, such as:

- the achievement of the financial, marketing, and business capabilities;
- filing and being compliant with SEC regulations;
- gaining the necessary knowledge to determine the optimal tax and legal structure;
- participating in the Roadshow to sell the shares of the company.

The costs of going public can be divided into two categories:

1. Costs which are directly related to the registration and distribution of shares called *offering costs*;

[11] (Strategy& PwC, 2020)

2. Costs that are incurred during the preparation of the offering can be called *incremental organizational costs*. Generally, these costs are non-recurring.

Offering costs are directly attributable to the IPO process. Several types of costs belong to the first category. One among them is the underwriter's discount, which ranges from 5 to 7% of the gross proceeds. (Berk & DeMarzo, Corporate Finance, 2016) define the underwriter discount as a spread, that is, the discount below the issue price at which the underwriter purchases the shares from the issuing firm. There are many theories beyond the reason why this fee is that high. One theory by Chen and Ritter argued that the cause was *collusion among underwriters*. This theory has, over the years, found no real evidence to affirm it. Robert Hansen discovered that, instead, the reason could be identified in the low concentration of underwriters in the market. The underwriters are generally giant investment banks with an excellent reputation, so lowering prices can signal competitors a possible low quality of the shares. This phenomenon explains why the compensation for the underwriters that are expensive.

(Strategy& PwC, 2020) It identifies as offering costs and legal fees, external auditor fees, financial reporting advisor fees, printing costs, registration-related costs, and exchange listing fees. Legal fees are the fees that are due to the preparation of the registration statement. The external auditor fees generally include the cost of preparing the comfort letter and the cost related to the review of the registration statement. Financial reporting advisor fees include preparing the pro forma financial statements and the analysis of the elements that are part of the registration statement. Printing costs are the costs incurred, mainly for the filing of the SEC. The last type of cost is the exchange listing fee, which is the fee that must be paid to the stock exchange for the listing. Offering costs are costs that, normally, increase with the increase of the offering's gross proceeds. It can be noticed in **Fig. 7**:

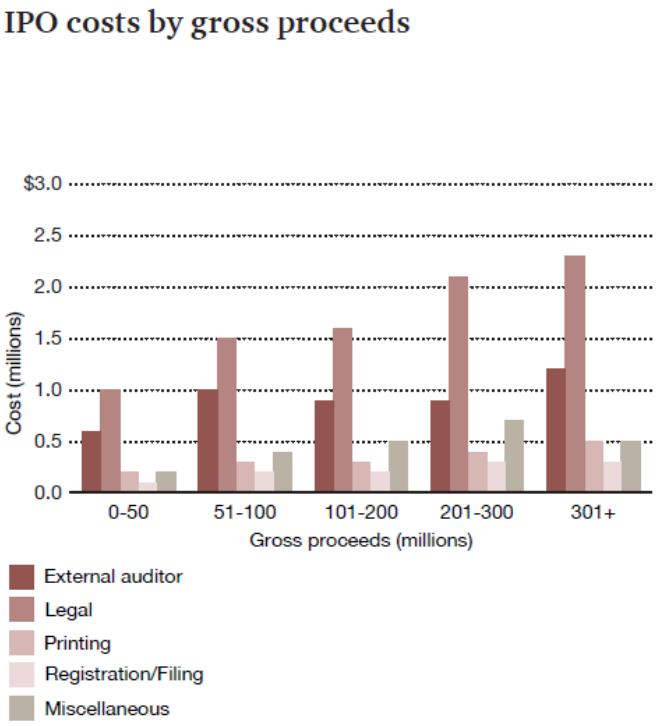

*Figure 7 – Offering costs – **Source**:* Strategy& PwC, Considering an IPO? The costs of going and being public may surprise you.

This chart shows that legal costs represent a high portion of the offering costs by gross proceeds. Companies wishing to go public should minimize them, making it clear that the filing is complete in each part and compliant with SEC regulation. Preparing an incomplete document is time-consuming and costly for firms. It is the primary source of additional expenses. One-time legal fees represent a high cost, especially for smaller firms, in which they represent 24% of the total proceeds.

Instead, *incremental organizational costs* entail creating a legal and organizational structure (called *restructuring costs*) necessary to execute the IPO. Restructuring costs are one-time costs paid to reorganize the business to improve its long-term efficiency (Restructuring Charge, s.d.)[12]. Incremental organizational costs vary based on the degree of companies' readiness, the level of external support they need, and the degree of complexity of the transactions[13].

[12] (Restructuring Charge, s.d.)
[13] (Strategy& PwC, 2020)

1.8.2. Costs of being public

Being public is the process that allows and sustains a private organization's transformation into a public company. Typically, the expenses incurred for developing the infrastructure that enables the company to operate in a public environment are severe.

In this process, financial reporting capabilities must be enhanced but not only these. Many areas of a company, while *being publi*c, must be improved. There must be the creation of teams focusing on several functions that can be created internally or externally to the company, depending on its needs. The main difference between a private company and a public one is the enormous amount of reporting and analysis requirements that a public company must manage. For this reason, additional staffing is needed in each area of the business. The following list tries to identify in which functional unit the additional staffing should be allocated to for companies having annual revenues between 500$ million and 1$ billion:

3. **SEC reporting team** includes a director and one or many managers, depending on the firm's size, of the financial reporting. This team must act to make each section of the filing compliant with SEC requirements;
4. **The taxation team** includes a director and one or more managers of taxation but also tax accountants. The team is responsible for compliance with the tax requirements at the state, federal and international levels. It also has to meet the requirements of *Section 404 of the Sarbanes-Oxley Act.* This function assumes rising importance due to the potential increase in the shareholder value obtained through an efficient and effective way of managing tax.
5. **Internal audit team** is composed of a director and internal audit manager, internal audits. This function's implementation is compulsory for firms listed on the NYSE but not for those listed on the NASDAQ. Different stock exchanges have other listing requirements. Internal audit has mainly two objectives. The first one resides in helping the management check the compliance with the Sarbanes-Oxley requirements. The second one comprehends matching the firm's risk management objectives with the company's policies and procedures. To cope with the increase in the importance of this function, companies can follow two strategies. The first strategy is merely hiring additional staff for the unit. The alternative is to commit external specialists to help the team. This second way can imply a higher cost than

adding staff to the internal division, but at the same time, it allows the company to make a faster scale up and down and can be a knowledge giver for the other components of the unit.

6. **The financial planning and analysis team** includes both a director and a manager of the function. Precise budgets and forecasts are crucial to ensure both a successful IPO and the pursuance of the public company's activities. A realistic earnings estimate can significantly impact the performance of the company's shares. The team of this unit is accountable for the level of accuracy used in budgeting and forecasting.
7. **Treasury and risk management** comprises a treasurer, an assistant treasurer, and a treasury analyst. This unit must ensure the mitigation of risks that a public company might incur, such as managing the liquidity, administrating foreign currency exposure, and the derivatives used to hedge interest rates.
8. **Human resources team**. This team's primary duty is to ensure that the compensation of employees is fully aligned with the compensation of comparable public companies to grant healthy competition. In addition to the compensation scheme, it is also responsible for creating compensation policies for executives and benefits plans for the workers.
9. **Technology support team**. The technology infrastructure of a public company must be robust. It must sustain the technology team to grant the compliance of system and processes with the *Sarbanes-Oxley* requirements. Moreover, it must also be helpful to enhance the financial reporting capabilities and investors relation.

These considerations analyzed in the list can be seen in **Fig. 6**, which shows on one axis the percentage of companies hiring new staffing in certain areas and on the other axis the functional areas.

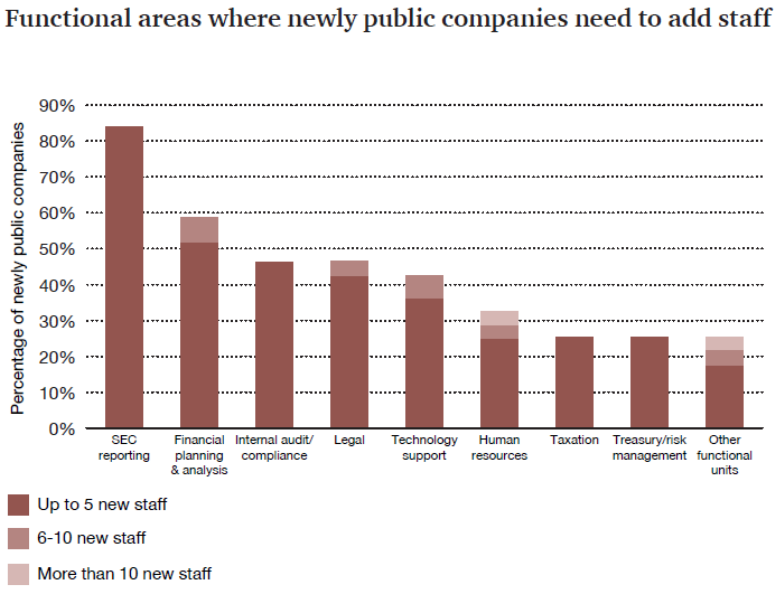

*Figure 8 – additional staffing - – **Source**:* Strategy& PwC, Considering an IPO? The costs of going and being public may surprise you.

Moreover, companies can also be helped by external staffing. According to PwC, 29% of companies spent more on additional staffing while being public rather than while going public. The external resources that are typically engaged by public companies are the following ones:

10. **The investor relation function** comprises a group of advisors that provides financial information and handles the requests deriving from shareholders, investors, or analysts. The benefit of deploying this unit is that it increases communication effectiveness among the company, the financial department, and the stakeholders. A manager of investor relations heads it.
11. **Financial reporting advisors.** This is generally an external accounting firm to which the public company asks to be helped with the transactions. This is an alternative solution to ask it directly to auditors.
12. **Compensation advisors.** This function might be very useful both in *going public* and in *being public* because, in the first part, it will help in the alignment of the compensation incentives of actual public companies. At the same time, it will take care of the governance mechanisms.

CHAPTER 2- UNDERSTANDING THE THEORIES

2. Literature theories

This chapter focuses on theories concerning underpricing and hot issue markets and will be essential for the subsequent empirical analysis.

2.1. Theories behind underpricing

Underpricing is a much-discussed topic in the existing literature. The theories trying to explain it can be summarized in four macro-areas: asymmetric information theories, institutional theories, control theories, and behavioral theories. The first category expresses that the issuing firm might know more than the underwriter (Welch 1989) or that informed investors might have more information than the firm and the underwriters (Rock 1986), or that the underwriters might have more information than investors and the firm (Baron 1982). The first cause of underpricing can be identified in the presence of asymmetric information.

2.1.1. Asymmetric information theories

1. (Ghosh, 2002) The first theory is called *the winner's curse*. Kevin Rock theorizes that there are two types of investors, the informed and the uninformed, and there are successful IPOs and unsuccessful ones. If the demand for an IPO is very high, the stocks will be rationed, and not all investors will receive the required number of shares. Moreover, informed investors would only bid on the IPOs they expect to be successful because they know which are the good IPOs and participate only in those. In contrast, uninformed investors participate in every IPO irrespectively to the quality of the offering. The underwriters, if the IPO price is set with the book-building method, will tend to favor and reward institutional investors providing reliant information. As a result, uninformed investors will receive the full number of required shares in bad IPOs and only receive a portion in good IPOs; they are rationed out. Uninformed investors are the injured party; they are the victims of the winner's curse (Rashid, Sibdoyal, Islam, Rahman, & Ahsanur., 2019).

A problem arising is that the issuing firm also needs the uninformed investors' money to reach the target amount. Thus, companies going public set a lower price at the IPO date to attract that kind of investor. The demand deriving from informed investors is usually too

low. In this sense, underpricing does not only assume a negative connotation, but instead, it is advantageous for the firm to increase the demand. It is the necessary consequence of the winner curse.

Theories show how to reduce the asymmetric information between those two kinds of investors. It can be achieved in the following ways:

- hiring a good quality underwriter (it can be measured by the ranking firstly created by Carter and Manaster in 1990 and then review by Ritter or by using the underwriters' market share);
- hiring a good quality auditor ((Beatty, 1989): the high quality of an auditor can be measured by two factors: comparative advantage over similar firms and the payment of a premium price. Companies try to hire the best quality auditors to ascertain the validity of information disclosed by them before the IPO, thus reducing the uncertainty and consequently underpricing.);

On this point, the evidence is mixed, and it has been shown that it depends a lot on the year of IPO. In fact, researches conducted between 1970 and 1980 reported a negative relation among quality underwriters and underpricing, while the following study by Beatty and Welch in 1990 showed a positive association. The reason why this shift happened is still unknown. A possible explanation identified by Ritter is that nowadays, the underwriters underprice IPOs intentionally. Another theory by Habib and Ljungqvist in 2001, instead, pointed out that the reason can be identified in the relation between underwriters and issuer firms itself. In other words, the issuing firm will choose a specific underwriter based on the underpricing it expects. On the other side, even the underwriter agrees to help only specific companies go public. This theory has been nominated as the **endogeneity biases**. It states that risky firms will try to minimize their underpricing by choosing a good reputation underwriter. Simultaneously, for stable companies, the careful choice is not that useful since they will expect a contained underpricing level.

2. The literature shows that the level of underpricing is positively related to ***the ex-ante uncertainty*** (Ritter 1984). Empirical evidence mainly focuses on the firm characteristics to measure the uncertainty, such as:

- the size of the company when the IPO took place;
- the age the firm had at the IPO date;
- the industry of the firm;

- the number of uses of the proceeds that are described in the prospectus;
- the level of risk factors described in the last section of the prospectus.

Thus a firm is considered risky if it has a small size, young age, a low number of uses in the prospectus, and a high number of risk factors depicted. Another approach studied in the literature is to consider the uncertainty high for some specific uses. For instance, the literature shows that the proceeds raised only to finance operational expenses are expected to entail a high risk (Ljungqvist and Wilhelm 2003).

3. Underwriters are aware that the underpricing level must **not be too exaggerated** because if this happens, they will lose in their stock market valuation (Nanda and Yun 1997).

4. Rock (1986) points out that in a situation in which the informed investor has better information about the good quality of the IPO than the underwriter will lead to underpricing since the investor is aware that revealing positive information will push up the offer price. Sharing positive information is in contrast with the incentive compatibility constraint.

The underwriters can resolve the incentive compatibility constraint by giving incentives to investors that share accurate information. The information-sharing can be achieved theoretically through the **book-building mechanism** because the underwriters can reward investors who do not misrepresent information. Moreover, the higher the volume of IPO deals of the underwriter, the higher the fear of the informed investors to be left out from future deals because they misrepresented the information.

Many countries in Europe enforce constraints about the shares allocation, in fact, some shares must be sold to retail investors that, with the underwriters' only discretion, will be left out. The constraints decrease the efficiency of the allocation leading to higher underpricing.

To conclude, this theory says that the information asymmetry can be reduced by sharing investors' information in the book-building process if they are appropriately rewarded; however, this has limits that can be imposed by national regulations. A way to measure investors' incentives to reveal the right information is to check the volume of deals concluded by the underwriter that manages the book-building process. A consequence of reducing asymmetric information is reducing the winner curse and reducing the underpricing level.

5. **The *principal-agent model*** theory states that the reduction of asymmetric information between underwriters and institutional investors achieved through the previously discussed arrangements can be costly for the issuing firm leading to an agency problem between the firm and the underwriter. The literature studied two phenomena that can benefit the underwriters from an increase in the underpricing:

- the underwriters can receive side-payments from investors that want to be sure to gain the shares;
- spinning: practice by which the underwriters grant underpriced shares to executives to obtain their business in the future;

A way to solve the principal-agent problem is to compensate the underwriters based on the gross proceeds by issuing firms; thus, the pay increases by decreasing the underpricing level. To prove this statement, it is necessary to check whether the underwriters' compensation is related to the amount of money raised in IPOs or the offering price. In fact, Ljungqvist (2003) demonstrated that if the underwriter's compensation is adequately related to the firm's valuation, then the underpricing is lower. To prove it, it is necessary to check if the underwriter has stocks of the issuing company is its stake. On this point, the evidence is mixed. In fact, Ljungqvist and Wilhelm (2003) showed that a high underwriter's equity holding corresponds to a low underpricing level. On the contrary, Muscarella and Vetsuypens (1989) proved that there is no correlation between the stake owned and the level of underpricing. The research shows that underwriters that underwrite their own IPO find no benefit related to the underpricing. They do not enjoy a lower level of underpricing.

In the past, the literature focused on agency theories related to the advantage that underwriters have in setting the price and saving on marketing and distribution of shares at the issuing firm's expense.

The theory is called *monopsony,* and states that underwriters take advantage of their position by lowering the price to avoid an additional marketing effort to attract investors. (West, 1965) This practice happens especially for smaller firms in which the underwriters, usually large well-established investment firms, have high bargaining power and grant the shares to favor their clients to improve their relations.

More recently, Baron and Holmström (1980) focused on quantifying the underwriter's resulting advantage by underpricing shares. The idea is based on the underwriter acting on behalf of the issuing firm in setting the price. The underwriter selects a combination of

spread and price, based on what it wants to achieve for its personal interest. If the demand expected is weak, the underwriter will set a low price to attract investors and a high underwriter's spread.

6. Another theory related to the asymmetric information among the firm and investors sees underpricing as a tool deployed by issuing firms in order to ***signal*** *to investors* the good quality of their firm (Allen and Faulhaber (1989), Grinblatt and Hwang (1989) and Welch (1989)). This theory says that in principle, the quality of a firm can be understood in the following way:

- at the beginning, investors are not able to understand the quality of a firm that is going to do an IPO;
- the high-value firm wants to signal its value to the investors, and the low-value firm follows what has been done from the high prospect firm in order to be seen as a winner firm;
- the financing process is divided into two stages:

    1. an IPO;

    2. a later stage financing after the IPO.

- the high-value firm is capable of leaving more money on the table, thus increasing the level of underpricing, knowing that this amount of money will be recovered in the later stage financing because, in the period from the IPO to the next financing stage, investors became conscious of the real value of the company. In fact, a low-value firm with any chance will not be able to recover the amount of money lost in the previous financing stage; for this reason, it generally does not underprice shares intentionally.

Complementary theories, as seen before, instead use different signals to decrease the asymmetric information between firm and investors that can be:

- Hiring a good quality underwriter, VC, or auditor;
- High-quality BOD.

Jegadeesh, Weinstein, and Welch have pointed out in 1993 evidence of what previously discussed showing that a high level of underpricing generally results in a higher probability of doing a SEO. In this case, the literature is mixed again because the next evidence by Michaely and Shaw one year later showed no correlation between the underpricing level

and the SEO. These theories culminate in the idea of Welch 1996 that summarizes this aspect by saying that the higher the amount of time from the IPO to the SEO, the higher the chances investors infer the firm's good quality. Thus, a high underpricing is positively related to an increased number of years before the SEO takes place. To conclude, the theory states that the stock price decrease after the SEO announcement should be more contained for high-value firms, thus leaving a higher amount of money on the table during the IPO than low-value firms.

Recapping, the asymmetric information theories are expressed in the following table:

Problem related to the asymmetric information between the two kinds of investors:	How to decrease asymmetric information:
1. **winner curse**: informed investors bid only on good quality IPOs while uninformed ones bid no matter the quality. It turns out that they will have many stocks in bad IPOs and therefore be tempted not to participate in the next IPOs. The demand from informed investors is not high enough to be able to allocate all the shares the company has proposed to sell, so the shares will be depreciated to attract even uninformed investors.	- Check for the good quality of underwriters - Check for the year in which the IPO takes place because there has been a sign shift in recent years.
2. **ex-ante uncertainty**: the higher the firm's uncertainty, the higher the level of underpricing.	How to decrease the uncertainty, by sharing more information such as: - the size of the company when the IPO took place; - the age the firm had at the IPO date; - the industry in which the firm operates; - the number of uses of the proceeds that are described in the prospectus; - the level of risk factors described in the last section of the prospectus.

3. underpricing can make underwriters lose in the stock price decline. It can be seen as a **trade-off** between: - issuing firm; the higher the underpricing, the unhappier the firm is, and the underwriter loses future business; - investors; the lower the underpricing, the lower return they can make by purchasing shares at the IPO price.	How to check this theory: - Higher level of overpricing results in a decrease in the shares price market value of the underwriter; - Low level of underpricing can result, instead, in an increase in its shares price.
Problem related to the asymmetric information between the informed investors and the underwriters: 4. **book building theory:** the investor better informed than the underwriter will be tempted not to reveal his positive information about the firm's good quality, thus avoiding a high offering price leading to underpricing.	How to decrease the misrepresentation by informed investors thus, reducing the asymmetric information: - The higher the IPO volume concluded by the underwriter, the lower the chances of investors to be able to lower the price because of the fear to be left out in the future by the underwriter; - Incentivize investors revealing the right information with the stock allocation. However, there can be national regulations to limit the mechanism.
Problem related to the asymmetric information between the issuing firm and the underwriters: 5. **principal-agent model theory**: the underwriters can have incentives to underprice shares at the expense of the firm.	How to decrease the benefit for the underwriter deriving from the underpricing: - Check if the underwriter's compensation depends on the offering price; - Check if the underwriter has a stake in the issuing companies to make it sensitive to the firm's valuation.
Problem related to the asymmetric information between the issuing firm and the investors:	How to check this theory:

6. **Signaling theory**: high-value firm can use underpricing to signal to the market the excellent quality of the offer, leaving on the table money that will be recovered in the future with a SEO.	- Check if there is a SEO after an IPO with a high underpricing; - Check if the higher the number of years spent from the IPO to the SEO, the higher the underpricing. How to reduce asymmetric information: - Check the good quality of VC, underwriters or BOD.

2.1.2. Institutional explanations

1. **lawsuit avoidance theory**: firms intentionally lower the issue price, causing underpricing because they fear lawsuits from unhappy investors that are not satisfied by the company's performance. This theory is mainly reflected in the United States. On average, in the United States, 6% of IPOs are then sued by investors, as shown by Lowry and Shu in 2002. This is costly for the firm in terms of money spent (13% of the gross proceeds), the time required, and reputation loss. For this reason, companies use underpricing as an insurance tool to protect themselves against potential litigations. Another form of protection against a lawsuit can be identified in hiring an experienced underwriter. In this case, the need for a high underpricing level reduces, according to Tinic in 1988.

Tinic also proposed a theory in which the level of underpricing changes after the Securities Act of 1933 because before the Act, issuing firms were more protected. Drake and Vetsuypens later disproved this theory in 1993, showing that the underpricing level of 1970 was lower than in the years before 1933. Moreover, Drake and Vetsuypens showed empirically that, on average, underpriced firms are more sued than firms with little underpricing. Thus, this theory can not be viewed as proved.

2. **price stabilization**: the price support is used not to allow the price to fall after an IPO occurs. It can be a useful tool to decrease the winner curse because it is deployed in overpriced IPOs in which the uninformed investors bear the cost. Underpricing, conversely, is offered not only to uninformed ones. It is very difficult to prove if the price support is a

widely used tool or not; Which are the IPOs that have been supported are generally known only to regulators.

There is empirical evidence in Chowdhry and Nanda (1996) literature and Benveniste, Busaba, and Wilhelm (1996). Underpricing decreases when there is price support because the need for it is reduced; however, it is still unknown how.

3. **Tax argument theory**: the underpricing can also be seen concerning the tax perspective. In the past, before 1990, in Sweden, capital gains were not subjected to taxes. This created a high incentive for firms to remunerate their own workers with underpriced shares during IPOs. After 1990, capital gains became taxed. The consequence of the law has been studied empirically by Rydqvist (1997), in fact, the underpricing level pre-law was more than 40%, and it subsequently fell to 8%.

The evidence that underpricing is a consequence of exploiting the tax advantage is mixed again. Taranto showed that, in firms in which employees are compensated through stock options, the higher the firm's reliance on stock options, the higher the underpricing. Employees who exercise the option pay income taxes on the difference between the strike price and the offering price. When employees sell the stock, they pay capital gain taxes on the difference between the offer price and the sale price. Managers have incentives to keep the offer price low, leading to underpricing.

Conversely, another theory explains instead that stock options can be used to protect the manager from dilution by anticipating underpricing.

1. **lawsuit avoidance theory**: firms intentionally underprice shares in order to avoid potential future litigations deriving from investors.	How to decrease the litigation problem: - Some theories identify the underpricing as the solution; - Other theories focus on the experience and good quality of the underwriter as a guarantor;
2. **price stabilization**: IPOs that were price-supported show a lower level of underpricing.	Challenging to be proved due to a lack of data availability.
3. **tax benefit**: it can not be depicted alone as an underpricing driver.	Challenging to be proved. In theory, a higher level of stock options granted to employees results in higher underpricing.

2.1.3. Ownership and control

IPO can be responsible for the separation of ownership and control. When the separation is not completed, agency problems can arise. In fact, the managers can protect their self-interests, sacrificing the potential benefit of the outside shareholders.

1. **Underpricing as a means to retain control** theory: the theory states that the manager is afraid of creating shareholders who own a large stake in the company because this allows more careful monitoring of his activities. The manager has discretion in the allocation of shares. For this reason, he will try to have a strong demand in order to be able to ration investors by granting them a small allocation of shares that do not guarantee control.

The theory has been proved by Brennan & Franks by checking whether the high demand issues lead to underpricing and so, to the dispersion of ownership.

Another theory by Zingales (1995) states that managers prefer dispersed ownership to grant a liquid secondary market. This may benefit managers to obtain a higher selling price for the ownership.

The main theory against the Brennan & Franks model, which states that underpricing is used to maintain control over the company, comes from Zingales in 1995; it states that the IPO can only be seen as the first phase of financing; at the end of the process the ownership will be transferred to new owners.

An alternative to underpricing to keep the control is identified in takeover defenses or merely the issuance of non-voting shares. Those particular shares might benefit or not the company. In other words, the discount at which they are sold can be higher or lower than the underpricing level. Evidence shows that firms issuing non-voting shares result in a lower amount of underpricing because it is not needed and also, in a higher ownership level.

2**. Underpricing as a means to reduce agency costs** theory: this theory is opposite to the previous one. The idea is that there is a trade-off between the private benefit a manager can try to achieve and the costs that he can bear if he does not correctly behave. In fact, the owners are the ones who suffer the agency costs. A possible solution is to grant a high stake to an outside shareholder in order to allow for better managerial control. The investor might not want to accept that high stake because it does not allow to diversify to decrease the risk. For this reason, to incentivize the large investors, underpricing can be added.

To conclude, ownership and control theories are not proved yet because more evidences are still needed; they are less studied than asymmetric information theories.

1. **underpricing as a means to retain control theory**: managers intentionally underprice shares in order to have high demand, thus leading to rationing investors, granting the firm control due to the dispersed ownership. In the alternative, non-voting rights can be issued to keep control over the company.	How to check this theory: - Some theories prove it by identifying the relation between underpricing and dispersed ownership; - Other theories checked the equity holding of directors before and after the IPO (they generally decreased); - Other theories checked the relation between underpricing and non-voting shares, which is another mechanism of control retention.
2. **underpricing as a means to reduce agency cost theory:** owners bear agency costs, and for this reason, they have incentives to allow a large external investor to monitor the actions allowing the value firm maximization. Underpricing is seen as an incentive to favor the large investor to monitor the managers' actions.	How to check this theory: - See how shares are allocated; - Check if a big increase in an investor's stake enhance the firm value; Challenging to be proved.

2.1.4. Behavioral explanations:

The level of underpricing has increased substantially since 1990. This growth cannot be explained only with the theories seen above. For this reason, behavioral theories were born, but like the agency theories, they still do not have enough evidence to certify them. Behavioral theories are based on investors' irrationality, which pushes them, in certain periods, to aggressive bidding or on the company's inability to reduce underpricing set by the underwriter.

1. **information cascades**: cascades can be a reason for explaining underpricing. The idea behind the theory is that investors may pay attention to demand deriving from other investors, such as informed investors. They might decide to purchase shares because other investors buy those shares (*Bandwagon effect*). This phenomenon can increase the demand for certain IPOs.

An investor may also not buy a stock, even if he has positive information about a specific offering, only because he has been influenced by other investors not purchasing it. To avoid or simply reduce this behavior, the underwriter might set a lower price to convince the early investors to buy the shares allowing other investors to follow them. This theory is also called *information cascades* (Rashid, Sibdoyal, Islam, Rahman, & Ahsanur., 2019).

In this context, early investors that make cascades happen embody a high power. For this reason, according to theory, they can be compensated with underpricing.

There are two cases in which this situation is not reflected:

- When the price-setting mechanism is the book building; in this context, the demand is kept secret by the underwriter. According to this theory, issuing firms using the book building mechanism should show a lower degree of underpricing since that it is not needed.
- When there is free communication between the investor: here, the investors, after sharing all the available information, have better knowledge than the issuing firm.

This theory has not been confirmed yet. In the literature, Welch proposed an idea in 1992 stating that underwriters can avoid the information free flow among investors if it has a national reach. This statement can be thought of as an extension of the theory relating underpricing to the underwriters' quality. To conclude, according to this theory, there should be a lower underpricing for national underwriters.

An issuing firm does not want to favor the free sharing of investors' information if it has, for example, a capital-constraint history. Thus, it will have higher incentives to hire a national underwriter.

2. **investors sentiment**: the idea behind the theory is that some kinds of investors, called the sentiment investors, can be very optimistic about the future of a firm going public. This aspect is particularly relevant for IPO firms because they are young with a little history behind them; thus, there is an aura of uncertainty around them.

In this context, the firm tries to maximize its value according to the positive sentiment that derives from the sentiment investors. In other words, the firm is not willing to sell a high amount of shares, not to make the price fall. Thus, it will sell underpriced shares only to institutional investors to keep them in their inventory and sell the shares to sentiment investors later. In other words, the underpricing in this theory is seen as a way to

compensate institutional investors for the risk that the hot issue market will end before the investors have been able to sell the whole package of shares.

There are significant consequences to the theory:

- Firms getting listed in hot markets might underperform later (the share price became lower than the offer price), by Miller in 1977;
- IPOs valuations are higher during hot periods, proved by Cook, Jarrell, and Kieschnick (2003);
- IPOs valuations are higher if, before them, a strong marketing campaign has been carried out, proved by Cook, Kieschnick, and Van Ness (2006);

To conclude, the theory states that institutional investors receive underpriced shares in hot issue periods and then sell overpriced shares to the retail investors, as proved by Ljungqvist, Nanda, and Singh in 2004. Thus, the beneficiaries of hot issue periods are the issuing firm and the underwriters' regular institutional clients.

3. **prospect theory and mental accounting**: this theory is different from the previous ones due to the belonging of the behavioral biases. In the previous ones, investors had behavioral biases driving them to follow an early investor or to believe in positive prospects. In contrast, in this theory, the issuing firm has a behavioral bias. Prospect theory and mental accounting theory try to explain the reason why the issuing firm is not upset by underpricing. The reference point, thus, what the firm believes is the real value of its shares, is identified in the offer price. The firm makes a trade-off between the loss deriving from the first-day underpricing and the gain deriving from the increase in the aftermarket's shares price.

Ljungqvist and Wilhelm proved the theory in 2005. The authors investigate when the manager of the company is satisfied with the issuance of the shares by the underwriter. They supposed that a pleased manager would hire again the same underwriter in a later issuance, a SEO. According to this theory, the beneficiaries from the satisfaction of managers are the underwriters, that are hired again and can make other fees from later transactions.

Nowadays, these theories are not yet well established, comparing them, for example, with asymmetric information theories.

1. **information cascades theory**: underpricing is a compensation tool for	How to check underpricing:

early investors that make the cascade happens.	- It should be low if the pricing method used is the book building; - It should be low if the underwriter is a national underwriter that can prevent the free flow of information; Not confirmed yet.
2. **investor sentiment theory**: a limited supply of shares is sold to institutional investors to avoid making the price fall. The shares are underpriced to compensate for the risk of the potential end of the favorable period. The higher valuation of the firm getting listed can be brought by investors' positive sentiment or by a strong marketing campaign.	How to check the theory: - A theory proved that the higher the marketing effort (measured by the number of articles talking about the IPO), the higher the valuation; - Another theory checked the share price later to connect the underpricing to the long term underperformance; - Another theory proved that the IPO average between 1980 and 1997 was overpriced compared to the sector's peers, by Purnanandam and Swaminathan.
3. **prospect theory and mental accounting**: the behavioral bias is on the firm that is not worse off with underpricing due to a wealth deriving from a later increase in shares price in the aftermarket. A satisfied firm will hire the same underwriters in future SEOs again.	How to check the theory: - Evidence proposed by Ljungqvist and Wilhelm checked if the lead underwriter of the IPO is the same as subsequent SEOs, then the manager is supposed to be satisfied with the underwriter activities, no matter the level of underpricing (thus, the loss incurred).

2.2. Theories behind hot issue markets

(Ritter, 1984) Professor J. Ritter theorizes that the average underpricing considering IPOs from 1977 to 1982 was 16.7% but it was not constant in every window of time he considered. An example can be found by extrapolating fifteen months in 1980 (starting from January). In fact, the average return in that window, was higher, approaching almost a return of 49%.

In these windows of "hot issues" the high risk IPOs show a higher level of underpricing compared to the low risk firms. Ritter thought that this could be the explanation of the phenomenon. Thus, hot issue periods can be identified by the presence of high risk IPOs.

By studying the change in the level of risk of companies, however, Professor Ritter understands that this cannot be the explanation. The professor finds the explanation in a particular sector, which is that of natural resources. Ritter created the following chart to allow the vision of "hot issues".

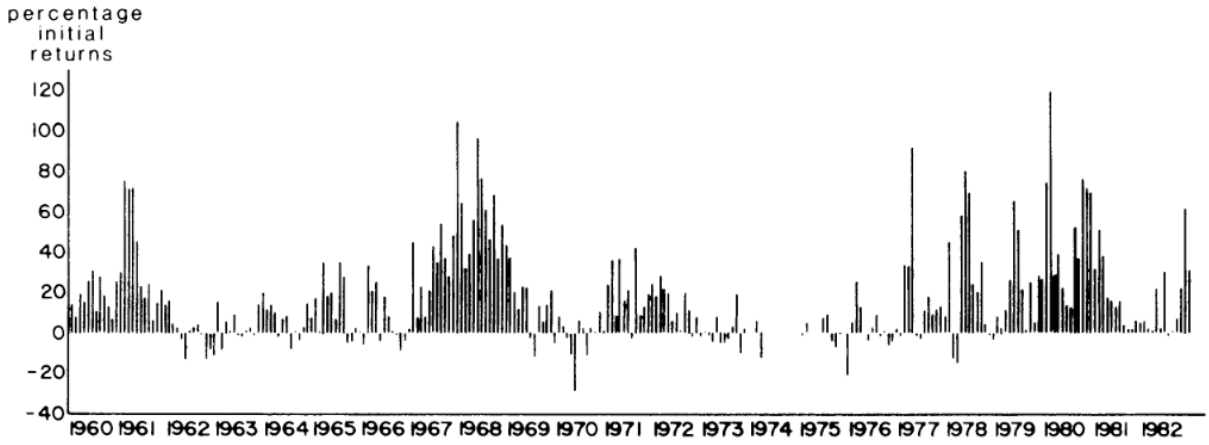

*Figure 9 – Percentage of Initial Returns from 1960 to 1982 – **Source**: The 'Hot Issue' Market of 1980, J.R. Ritter*

Moreover, J. Ritter reported also the underpricing grouped by industry to demonstrate visually his statement. Two charts are reported below referring to IPOs from 1977-1982; the first one concerns the initial returns for industries that are different from the natural resource one; the second one, instead, allows to visualize the initial returns belonging to the natural resource industry. It is important to point out that, hot issues generally are followed by an increase in the IPOs volume.

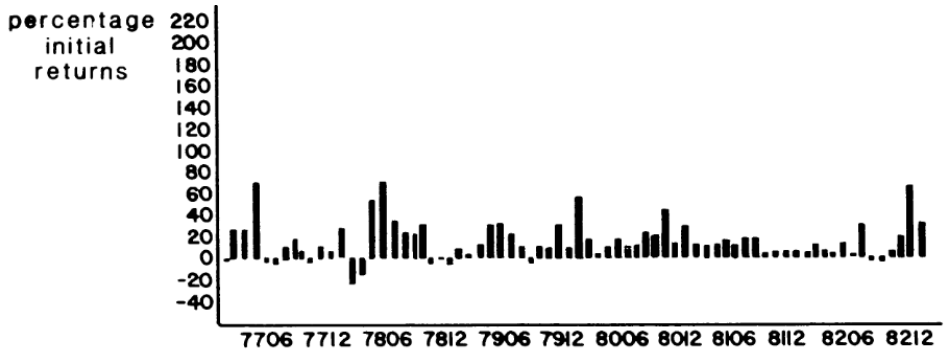

*Figure 10 – Percentage Initial Returns of Non-natural resource issues – **Source**: The 'Hot Issue' Market of 1980, J.R. Ritter*

For non-natural resource issues, Ritter discovered that there is a very low autocorrelation of monthly initial returns. There is almost no evidence of a hot issue window.

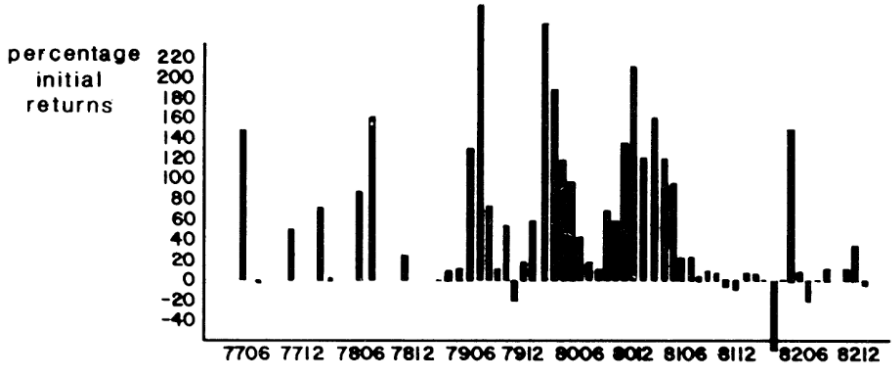

Figure 11 – Percentage Initial Returns of Natural resource issues – ***Source****: The 'Hot Issue' Market of 1980, J.R. Ritter*

Instead, Ritter found that, in the natural-resource issues:

- monthly initial returns for natural resource issues show a high level of autocorrelation;
- there exists a positive relation between risk and underpricing; it is non-stationary (unpredictable and impossible to be forecasted);
- the high underpricing window of 1980 can be due to the exploitation of the "Gas and Oil Boom", by underwriters. In fact, this phenomenon ended.

CHAPTER 3 – traditional valuation methods

3. Overview of valuation methods

Company valuation is a much-discussed topic in the literature. (Quiry, Dallocchio, Fur, & Salvi, 2018) A possible classification of valuation methods can distinguish them into direct and indirect methods. *Direct methods* are also called empirical methods because they base the valuation on market data; therefore, the value is deducted directly from observations of indicators or parameters. For example, they can be based on market prices in reference to other comparable companies. On the other hand, *indirect methods* are based on quantities that refer to the company to be evaluated.

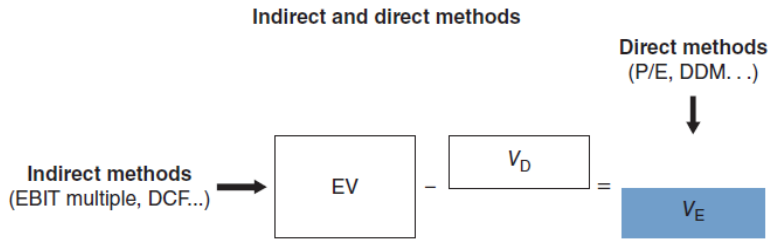

*Figure 12 – Direct and Indirect Methods – **Source**: Quiry, Dallocchio, Fur, & Salvi, Corporate Finance Theory and Practice*

Fig. 12 shows that, in indirect methods to estimate the equity value, firstly, the enterprise value must be evaluated; Then, the net debt must be subtracted from the firm value.

According to (American Institute of Certified Public Accountants (AICPA), 2013), the primary methods to estimate the value of a company and its securities can be classified into three macro-categories, as follows:

- Market approach;
- Income approach;
- Assets approach.

The best estimation can be obtained by specialists using a combination of the above categories. Valuing a company is a difficult task, and it can lead to discrepancies in the methods used; Different methods might result in a different estimation. If it happens, the specialist must analyze in the deep the process and determine the possible reasons.

3.1. Market approach

A market approach has been defined by the Financial Accounting Standards Board (FASB) as: *<< it is a valuation technique that uses prices and other relevant information generated by market transactions involving identical or comparable assets, liabilities, or a group of assets and liabilities, such as a business.*[14]*>>*.

Thus, the estimation through the market approach is obtained in reference to what the value is for comparable companies.

In turn, two categories belong to this method:

1. *Public company comparable methods*; this method's result is the determination of publicly listed companies' multiples to create a useful benchmark for the company's valuation. First of all, we need to create a sample of similar public companies; It must include companies that operate in the same industry, in a similar geographical position, and with similar levels of market capitalization and revenues. Companies' sample should also be similar regarding the ROCE and expected growth (Quiry, Dallocchio, Fur, & Salvi, 2018). After having decided the sample, the multiple has to be determined. Then, an average of the multiples of the public companies will be calculated. Determine the final value of the company deploying the average multiple.
2. *Precedent transaction methods*; In this method, the share price evaluation is obtained by likening it to past transactions. The companies' sample must be selected so that the companies included in it belong to the same industry and have a similar financial structure. Besides, past transactions and the company's transactions to be evaluated should be of the same size and purpose.

The comparable company analysis, called "*comps analysis*," can be generalized with the following steps, such as:

1. *Select the sample of comparable companies*; important step regarding the accuracy of the evaluation. In fact, it is given by the carefulness of the match between the target company and similar companies.

[14] https://asc.fasb.org/help&cid=1175804734816#master_glossary_1176153627844

2. *Collect financial information;* information about public companies can be extrapolated from databases as Bloomberg Terminal or Capital IQ or directly through the companies' reports.
3. *Create the table of comparables*; this table should include metrics about the sample's companies as EPS, EBITDA, revenue, enterprise value, market capitalization, net debt, and shares price.
4. *Determine the comparable ratios;* some ratios customarily used are the market-to-book ratio, the price earning ratio**,** enterprise to revenue ratio, enterprise to gross profit ratio, EV/EBITDA, etc.
5. *Valuation of the target company using the multiples from the comparable;* this step starts with calculating the average multiple. Then, the average multiple will be multiplied by the metrics written in the table of comparables.

3.1.1. Multiples

(Quiry, Dallocchio, Fur, & Salvi, 2018) The multiples deriving from the sample of comparable public companies are called *market or trading multiple.* In contrast*,* the multiples resulting from the sample of past transactions of companies being sold are called *transaction multiples*.

Multiples are mainly divided into those based on enterprise value and those based on the value of equity. The difference between the two categories is that as regards the first, they generally come from operating balances before interest expense. In contrast, in those of the second category, the interest expense is accounted for. Moreover, equity multiples provide a direct estimation of market capitalization. The enterprise value multiples are independent of the capital structure, while equity value multiples indirectly value the company's financial structure. From the enterprise value, the value of equity can be determined by subtracting from the EV the net debt.

3.1.1.1. Enterprise value multiples

(Berk & DeMarzo, Corporate Finance, 2016) This method is used primarily for a sample of firms with different leverage because it does not only consider the equity value, but the enterprise's full value before the debt is repaid. The multiple is obtained by dividing the enterprise's value by the measures before interest payments of cash flows or earnings. The multiple most used is enterprise value to EBITDA (Earnings before interest, taxes,

depreciation & amortization) because capital expenditure can vary depending on the period taken into account. Other widely used multiples deploy EBIT and free cash flow.

$$Enterprise\ to\ EBITDA = \frac{V_0}{EBITDA}$$

Moreover, if it is expected a constant growth of the free cash flow, the formula will be the following one:

$$\frac{V_0}{EBITDA} = \frac{\frac{FCF}{EBITDA}}{r_{wacc} - g_{FCF}}$$

(Quiry, Dallocchio, Fur, & Salvi, 2018) The enterprise to EBITDA is high when the growth rate is high, and the capital requirement is low. This multiple is mainly used in capital-intensive sectors.

The multiple based on EBIT, instead, can be calculated as in the next formula:

$$Enterprise\ to\ EBIT = \frac{Enterprise\ value}{Operating\ Profit}$$

Three factors are driving the EBIT multiple:

1. *Operating profit's growth rate*; high growth expectations leads to a higher EBIT multiple. Investors, indeed, are more willing to pay more if they see high growth.
2. *Risk of the capital employed*; sometimes, it can be noticed a high growth rate and related low multiple. This affirmation seems a contradiction to what has been stated before. The reason can be identified in the risk of the company. Indeed, investors do not consider the high growth expectation as *a built-in stone*. The increased risk of a company manifests itself in a lower multiple EBIT because investors, to account for a higher risk, discount the future expected EBIT at a very high rate leading to a lower multiple.
3. *Interest rate level*; The higher the interest rate, the lower the multiple will be, as investors demand higher returns, lowering assets' value, as said before.

A consideration to be made is that, if we consider companies from different countries, which therefore pay a different tax rate, it is more appropriate to use the NOPLAT (*Net Operating Profit After Taxes*) instead of the operating profit as shown below:

$$NOPLAT = Operating\ Profit\ \times\ (1 - tax\ rate)$$

2.1.1.1.1. Enterprise Value

(Berk & DeMarzo, Corporate Finance, 2016) The enterprise value can be calculated according to the following formula:

$$Enterprise\ Value = Market\ Value\ of\ Equity + Debt - Cash$$

The market value of equity is the amount remaining after that the debt has been paid. It is measured by the market capitalization, as follow:

$$Market\ Value\ of\ Equity = Shares\ outstanding\ \times Market\ Price\ per\ Share$$

The enterprise value is also called TEV, total enterprise value. This value is separated from cash and securities that can be easily bought and sold. The enterprise value can also be seen as the amount to pay for buying a company.

2.1.1.1.2. Example with EBIT

€m	ThyssenKrupp	Voestalpine	Salzgitter	Nippon Steel	US Steel
Market capitalisation (value of equity)	10 456	4 998	1 555	16 061	1 789
+ Value of debt	4 421	3 918	344	16 374	2 210
= Value of capital employed (*A*)	14 877	8 916	1 899	32 435	3 999
2017e Operating income (EBIT) (*B*)	1 741	875	204	2 077	166
2017e EBIT multiple (*A*/*B*)	8.5	10.2	9.3	15.6	24.0

*Figure 13 – EBIT multiple – **Source**: Quiry, Dallocchio, Fur, & Salvi, Corporate Finance*

With enterprise value multiples, firstly, must be valued the capital employed for each firm previously chosen. **Fig**. **14**. shows an example of comparable firms extrapolated in 2016. The target company is ArcelorMittal. Market capitalization has to be summed with the net debt value to obtain the capital employed value. In 2016, ArcelorMittal showed a high growth of EBIT; for this reason, the multiple that better suits it is the Nippon Steel multiple, which is the highest among the sample of firms.

ArcelorMittal 2017	**[millions $]**
EBIT	2636
multiple	15.6
Enterprise value	**2636*15,6 =41121.6**

Table 6 – Enterprise value calculation

ArcelorMittal 2017	[millions $]
Enterprise value	41121.6
Debt	26480
Equity value	**41121.6-26480=14641.6**

*Table 7 – EBIT calculation – **Source**: Quiry, Dallocchio, Fur, & Salvi, Corporate Finance*

3.1.1.2. Other multiples

Many other multiples can be deployed. Usually, some multiples are more specific for particular industries. (Quiry, Dallocchio, Fur, & Salvi, 2018) For example, companies belonging to the Internet industry generally rely on the number of subscribers or visitors for specific web pages. For small companies having many transactions, the operating multiple more suitable is calculated with the turnover; in this context, it is a better indicator of the profitability. Moreover, these other multiples are mostly deployed in firms that are not profitable yet.

(Berk & DeMarzo, Corporate Finance, 2016) The sales multiple (Price-to-sales ratio) can only be useful if an underlying assumption is valid: the company must maintain a similar margin over time.

3.1.1.3. Equity value multiples

(Berk & DeMarzo, Corporate Finance, 2016) The Price-Earnings ratio is the most widely used valuation multiple. The formula of the P/E ratio follows:

$$P/_E \ Ratio = \frac{Share\ Price}{Earnings\ per\ Share}$$

The same formula can be written to consider the aggregate values:

$$P/_E \ Ratio = \frac{Market\ Capitalization}{Net\ Income}$$

This ratio is used to check whether a stock is undervalued or overvalued. The assumption behind it is that a share's value should be proportional to the shareholders' earnings. The sector in which a company belongs affects P/E. Furthermore, P/E is higher for companies belonging to industries in which expected growth rates are significant. Also, riskier companies will have lower P/E. In fact, based on 2015 data, a large American company has a P/E of around 21; the software companies of about 38; the automotive sector instead of

about 15. It is generally not suitable for comparable firms with different leverage levels. In this context, is preferred an enterprise value multiple. Moreover, when the earnings are negative, the P/E ratio is not useful; it is deployed the enterprise value to sales. The next table shows the substantial difference between the P / E in the various European sectors.

HISTORICAL P/E RATIOS – PAN-EUROPEAN SECTORS (AS OF JANUARY 1ST)

Year	Automotive	Biotechnologies	Chemistry	Defence	Financial Institutions	Food	Oil & Gas	Real Estate	Telecom	Utilities
1990	6.7	21.7	8.3	6.9	16.1	14.1	11.2	24.8	12.8	11.1
1995	13.4	30.4	13.5	14.3	14.1	12.9	17.3	20.4	12.7	13.4
2000	13.2	180.5	18.4	19.0	19.3	17.1	38.5	21.2	51.7	17.3
2005	12.6	25.6	24.9	32.6	15.8	17.8	15.4	19.6	20.5	13.9
2010	52.5	19.0	20.4	10.4	13.8	11.8	18.4	13.0	12.3	11.2
2011	14.3	23.1	13.0	16.9	10.1	18.3	8.8	16.2	10.3	10.2
2012	4.7	20.2	7.4	15.1	7.8	17.0	7.3	9.9	11.0	9.9
2013	5.7	25.8	13.8	13.7	12.3	19.2	7.3	18.2	10.7	10.1
2014	8.8	34.2	15.7	19.2	14.4	19.6	8.9	18.7	15.5	12.1
2015	8.6	25.0	14.9	17.2	13.4	22.3	11.0	17.1	17.0	13.6
2016	9.8	40.3	13.4	17.1	11.9	16.3	16.8	17.8	20.2	14.0
2017	9.5	31.5	19.0	18.1	10.2	23.4	25.1	16.5	13.5	13.6

*Table 8 – average P/E across sectors – **Source**: Quiry, Dallocchio, Fur, & Salvi, Corporate Finance*

Companies that exhibit a high P / E ratio may have overvalued stocks or have investors who rely on a high growth rate.

(Massari, Gianfrate, & Zanetti, 2016) The P/E ratio shows how much the market is willing to pay for a stock today, basing the valuation on its past or future earnings, and can be calculated following methods:

- *Forward or Leading P/E*: the multiple takes into account the future 12 months;
- *Trailing P/E*: instead, it is calculated based on the previous 12 months.

There are more concerns around future earnings when evaluating a company; For this reason, the forward P/E is generally preferred. The formula is the following one:

$$Forward\ {}^{P}/_{E} = \frac{P_0}{EPS_1} = \frac{\frac{DIV_1}{EPS_1}}{r_E - g} = \frac{Dividend\ Payout\ Rate}{r_E - g}$$

The last rearrangement of the formula has been calculated assuming constant dividend growth ($P_0 = \frac{DIV_1}{r_E - g}$) and dividing both sides by EPS_1. The dividend payout rate is the rate of earnings paid to shareholders under the form of dividends.

(Quiry, Dallocchio, Fur, & Salvi, 2018) The difference between the multiples that use EBIT and P/E is that the latter reflects the risk. P/E tends to be lower when the perceived risk is more significant. Moreover, multiple based on P/E can be used, only with comparable companies having the same EPS growth and the same financial and operating risks.

Other multiples based on equity value are the price-to-book ratio or market-to-book ratio and the cash flow multiple ratio (= market capitalization/cash flow).

$$P/_B \ Ratio = \frac{Market\ Value\ of\ Equity}{Book\ Value\ of\ Equity}$$

This ratio for prosperous firms is higher than one. In this case, it means that the assets of a firm worth more than their historical cost. Average large companies in the United States have a ratio of about 2.9, while larger banks, in the same place, of 1.9. Companies can also be classified based on their market-to-book rate. In fact, companies having a high P/B ratio are appointed as *growth stocks*; on the contrary, firms with a low P/B are nominated as *value stock*s.

3.1.1.3.1. Example of multiple calculations with P/E

Resuming the last example on ArcelorMittal, the multiple used is the P/E of Nippon Steel.

€m	ThyssenKrupp	Voestalpine	Salzgitter	Nippon Steel	US Steel
Market capitalisation (*A*)	10 456	4 998	1 555	16 061	1 789
2017e Net income (*B*)	841	710	101	1 530	3
P/E ratio (*A*)/(*B*)	12.4	7.0	15.4	10.5	NS

*Table 9 - P/E multiple calculation – **Source**: Quiry, Dallocchio, Fur, & Salvi, Corporate Finance*

ArcelorMittal 2017	[millions $]
Net income	718
P/E ratio	10.5
Equity value	**718*10.5=7539**

Table 10 – Equity value calculation

To summarize, multiples can be grouped in two categories such as equity value and enterprise value multiples. To calcolate multiples, to approaches can be followed such as, evaluating a sample of public companies or evaluating past M&A transactions of companies in the same industry of the company we are willing to evaluate.

Normally, the enterprise value multiples are preferred to the equity value multiples due to:

- EV multiples are indifferent to the capital structure (a change in it does not change the multiple) because they make possible the direct comparison among different companies;
- Less sensitive to accounting changes;

Investors, instead generally prefer equity value multiples because they are easier to compute and to be found in many financial websites.

To facilitate reading, I collect the mostly used multiples explained above with the relative formulas in the following table.

Multiple	*Formula*
Enterprise to EBITDA	$\frac{Enterprise\ Value}{EBITDA}$
Enterprise to EBIT	$\frac{Enterprise\ Value}{\text{Operating profit}}$
P/E ratio	$\frac{\text{Share price}}{\text{Earning per share}}$ or $\frac{\text{Market capitalization}}{\text{Net income}}$
P/B ratio	$\frac{\text{Market value of equity}}{\text{Book value of Equity}}$

Table 11 – Summary of the most important multiples and their formulas

3.2. Income approach

The definition reported in the glossary of FASB Accounting Standards codification of income approach is <<*a general way of determining a value indication of a business, business ownership interest, security, or intangible asset using one or more methods that convert anticipated economic benefits into a present single amount.*[15]>>

3.2.1. DCF – Discounted Cash Flow

(Quiry, Dallocchio, Fur, & Salvi, 2018) The valuation technique mostly used of the income approach methods is the DCF that is a method to estimate the real value of a firm. The formula can be expressed as follow:

[15] (American Institute of Certified Public Accountants (AICPA), 2013)

$$EV = \sum_{t=0}^{\infty} \frac{FCF_t}{(1+k)^t}$$

Net operating cash flows are forecasted over a specific number of years, usually called the *explicit forecast period*. The length of the period is variable and depends on the sector in question. Indeed, a company in the high-tech industry can have a period of 2 to 3 years, while if we consider utility companies, the duration of the period can be up to 30 years. The average of this period has been found between 5 and 10 years.

The explicit forecast period's length should not be too long or too short; it must be equal to a reasonable period. For example, it can be assumed that it is appropriate to forecast for a period in which the company keeps the same configuration of assets; otherwise, the forecast might become only a meaningless theoretical tool.

The FCFs are then discounted at the company's cost of capital. Subsequently, the net operating cash flows for the period following the explicit forecast period, called terminal values, are estimated using simplifications.

The conclusion is that the company's value is given by the sum of the cash flows, calculated after taxes, discounted to the present, over the explicit period and the terminal value.

3.2.1.1. Determination of Free Cash Flows

To calculate the stock's fair value (the difference between the market value and the book value), the discounted cash flow method can follow two approaches, one based on FCFF and the other one referring to the FCFE.

(Quiry, Dallocchio, Fur, & Salvi, 2018) FCF represents the free cash flows in the previous formula, which is the available cash flow to investors having taken into account investments in working capital, taxes, and debt cash flow. It is a measure of the production capacity of cash of the firm. There must be consistency with the discount rate when discounting the cash flows. The free cash flows can be of two types (Borsa Italiana, 2020):

- *Free Cash Flow to Equity* (FCFE) or *Levered Cash Flows* discounted using CAPM model; it is the cash flows available to equity investors, and it is also known as cash flow after that the company met its financial obligations;
- *Free Cash Flow to Firm* (FCFF) or *Unlevered Cash Flows* discounted at WACC; it is the cash flows available to debtholders and equity holders together;

FCFF & FCFE are calculated in the following way:

Calculation of FCFF
Operating Income (EBIT)
+ Depreciation & Amortization
- Normalized tax on operating income
- Change in working capital
- Capital expenditure
= FCFF

Table 12 – Free Cash Flow to Firm Calculation

Calculation of FCFE
Net Income
+ Depreciation & Amortization
- Change in working capital
- Capital expenditure
- Mandatory debt payments
= FCFE

Table 13 – Free Cash Flow to Equity Calculation

3.2.1.2. Cost of capital

As stated before, the discounted cash flow calculation using FCFF requires the weighted average cost of capital. In contrast, the estimate with FCFE is discounted at the cost of equity using the CAPM. (Quiry, Dallocchio, Fur, & Salvi, 2018) defines the cost of capital as << *the minimum rate of return on the company's investments that can satisfy both shareholders (the cost of equity) and debtholders (the cost of debt). The cost of capital is thus the company's total cost of financing*.>>

3.2.1.2.1. CAPM

(Borsa Italiana, 2009) The CAPM model is based on the principle that any investor holding a diversified portfolio if the markets are in equilibrium owns a fraction of both the company's debt and its equity. In other words, the investor holds a share of the company's operating assets[16] (assets generating revenue) as the amount of assets is equal to the sum of

[16] https://ycharts.com/glossary/terms/operating_assets, Operating Assets = Cash + Total Receivables + Inventories + Prepaid Expenses + Deferred Taxes + Net PP&E + Goodwill and Intangibles

debt and equity. The cost of capital depends only on the specific risk, thus on the risk deriving from the company's assets-in-place.

In a simplified world, the market portfolio will be the efficient one introduced by Tobin. The simplifications are: there are no taxes and transaction costs; investors have the same investment time horizon and the same views on expected returns and riskiness. In the world with those assumptions stressed, investing in securities exposes the investor to two kinds of risks:

- The diversifiable risk;
- The systematic risk or market risk;

The first type of risk can be eliminated by investing in a portfolio of financial assets, while the second one is intrinsic to the investment and can not be deleted.

As the economic system conditions influence the regular stock market trend, the expected return of the stock market will be greater than the risk-free rate.

(Quiry, Dallocchio, Fur, & Salvi, 2018) The CAPM provides the following formula to determine the cost of capital:

$$k = r_F + \beta_A \times (r_M - r_F)$$

Where:

- k = cost of capital;
- r_F = risk-free rate; it is the return on usually long/medium-term investments in non-risky securities without risk of default, liquidity, and coupon reinvestment;
- r_M = market rate of return;
- $r_M - r_F$ = market risk premium;
- β *of assets* also called *unlevered* β = a measure of the responsiveness of a security's return to market movements. Thus, a market risk measure.

Beta	
> 1	The stock is more responsive than the market
< 0	The stock moves in the opposite direction to the market
0 < β < 1	The stock is less responsive than the market

*Table 14 Unlevered Beta – **Source**: Borsa Italiana*

The previous formula states that thanks to the CAPM model, the expected return of a security is the sum of the risk-free rate and a risk premium. The risk premium expresses the non-diversifiable risk and depends on beta. Beta, as mentioned before, measures the

reactivity of a stock's return to market movements. In conclusion, the higher the beta, the greater the non-diversifiable risk, and therefore the higher the expected return on the stock.

β_A is determined with the weighted average of β_E & β_D, as follows:

$$\beta_A = \beta_E \times \frac{E}{E+D} + \beta_D \times \frac{D}{E+D}$$

Rearranging the formula:

$$\beta_A = \frac{\beta_E + \beta_D \times \frac{D}{E}}{1 + \beta_D \times \frac{D}{E}}$$

Moreover, the previously-obtained formula can be simplified if the company has only a little leverage, β_D is assumed to be zero :

$$\beta_A = \frac{\beta_E}{1 + \beta_D \times \frac{D}{E}}$$

Where:

$$\beta_E = \beta_A + \frac{D}{E} \times (\beta_A - \beta_D)$$

β_E increases with the leverage level.

Usually, β_A is lower than one when β_E tends to be around one. β_A can vary a lot depending on the sector to which the firm belongs, as shown in the next table:

	Asset beta		Asset beta
Water Utilities	0.40	Pharmaceutics	0.85
Tobacco	0.41	E-commerce	0.87
Real Estate Investment Trusts	0.44	Hotels	0.92
Spirits	0.60	Construction Materials	0.95
Food retail	0.61	Chemicals	1.00
Telecom	0.61	Automotive	1.02
Food industry	0.65	Advertising	1.02
Casinos	0.69	Software	1.08
Banks	0.79	Steel	1.12
Aerospace and defense	0.81	Airlines	1.45
All Sectors[2]	**0.81**		

*Table 15 – Average Asset Beta across Sectors - **Source**: Quiry, Dallocchio, Fur, & Salvi, Corporate Finance*

It is noticeable that the average of all sectors is anyway below 1.

3.2.1.3. WACC

The weighted average cost of capital is the return expected by all the company investors; All the securities of a firm must be valued to compute it. The formula is the following one:

$$r_{wacc} = r_E \times \frac{E}{E+D} + r_D \times \frac{D}{E+D} \times (1 - T_c)$$

WACC is the effective cost of capital after tax.

The previous formula can be arranged as follows, given a target leverage ratio:

$$r_{wacc} = r_U - r_D \times T_C \times \frac{D}{E+D}$$

Thus, r_{wacc} can be seen as the unlevered cost of capital less the benefit deriving from tax deductibility. In fact, the unlevered cost of capital can be called the *pre-tax* r_{wacc} and it is the return that investors expect to earn by holding the firm's assets.

3.2.2. Termination value

(Quiry, Dallocchio, Fur, & Salvi, 2018) Determining the *terminal value,* also known as *continuing value* and *horizon value*, is not an easy task; generally, an assumption must be made. The terminal value can be calculated in two possible ways, assuming that the firm, after the explicit period of forecast, enters into a maturity phase. Firstly, it can be based on a normalized free cash flow or on capital employed when the explicit period ends. The normalized free cash flow will usually be different from the free cash flows that are calculated in the last year of the explicit period. This happens because the normalized cash flow is what the firm will generate in perpetuity after the explicit period. For this reason, the normalized cash flows are assumed to be an annuity and to grow in perpetuity; thus, the Gordon formula can be used.

$$EV\ when\ the\ explicit\ forecast\ period\ ends = \frac{Normalised\ free\ CF}{r-g}$$

The second way to estimate the *terminal value* is using the multiples that can be referred to as *horizon multiples*. Horizon multiples can be constructed on EBIT, EBITDA, or turnover and generally differ from multiples using operating performances because the growth is assumed to reduce overtime; In fact, they are supposed to be lower.

Moreover, few considerations between the difference between terminal value and book value have to be made. First of all, estimating a terminal value greater than its book value entails that the firm will generate a return on capital employed, more significant than

the cost of capital, in perpetuity. On the other hand, estimating a terminal value lower than its book value states that the firm is supposed to enter a decline phase after the explicit period; thus, it will never generate a higher return than the weighted average cost of capital anymore. The last possibility is to estimate a terminal value that is precisely the same as the book value. In this case, it is automatically assumed that the economic profit will be lowered to zero.

Besides, usually, a high economic profit is not easily sustainable over time. In fact, the return on capital of a firm progressively approaches the cost of capital.

To include this phenomenon into the terminal value calculation, generally, a cash flow fade period is forecasted. This approach consists of deciding the speed at which the expected return approaches the cost of capital or the length of the period after which the return converges to the cost of capital, called *the cash flow fade period* showed in **Fig. 15**.

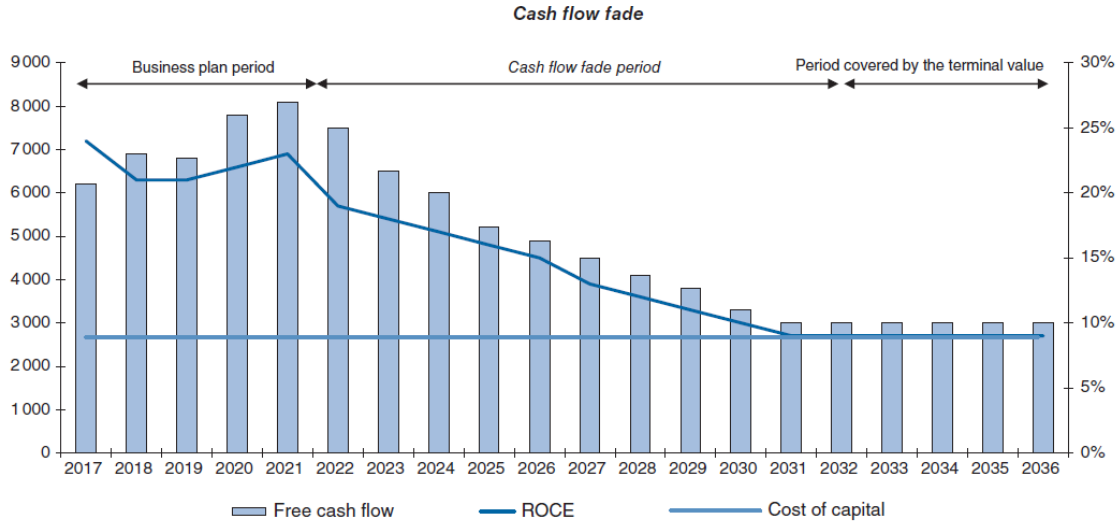

*Figure 14 – Representation of the Cash Flow Fade period - **Source**: Quiry, Dallocchio, Fur, & Salvi, Corporate Finance*

The explicit forecast period is referred to as the business plan period. After it, a period of transition follows, the so-called cash flow fade period. In the end, the terminal value will be estimated, and the expected return on capital employed will have reached the weighted average cost of capital of the company.

3.2.3. Drawbacks of the method

(Quiry, Dallocchio, Fur, & Salvi, 2018) It is the most used method. Often it is also the only one that can be used. For companies that do not make profits, the multiples approach is to be discarded a priori. It is a widely used method in negotiations; in fact, it manages to reconcile the buyer and seller's point of view. It allows the buyer to have more information about the company. The seller mostly uses the DCF because it is based on a

business plan, also called the explicit period forecast that generally relies on optimistic assumptions. The seller might be more interested in the multiple approach to prove that he can pay less than the value built with the DCF due to comparable companies on the market.

A clear advantage is that the valuation, using this method, is closely linked to the company's economic performance. On the other hand, the evaluation is too tied to the numerous assumptions making the method susceptible to the hypotheses. Predicting the future is not an easy task and makes the result of this approach very volatile.

Moreover, the valuation mostly depends on the calculation of the terminal value. It has been shown that many times, the horizon value is responsible for more than the 50% of the company's total value.

A significant disadvantage of the method is the difficulty in forecasting the cash flows in the explicit forecast period and after it.

3.2.2. DDM – Discounted Dividend Model

(Berk & DeMarzo, Corporate Finance, 2016) A variation of the DCF method can be represented in the DDM, Dividend Discount Model. Instead of the expected cash flow, it considers the expected dividend per share.

The assumptions of this method are:

- security is valued based on the cash flow that the investor hopes to obtain;
- the valuation of a security does not depend on the time horizon if the investors have the same beliefs.

Starting from an investment period of one year, it easily understandable that an investor can profit by obtaining a dividend from the company or through the sale of a stock that has increased its price, as shown in **Fig. 16**. It often happens that companies, mostly young ones, do not distribute dividends in order to reinvest money in profitable projects, allowing the share price to increase. Conversely, mature and well-established firms tend to distribute dividends to communicate that they are prosperous and attract new investors.

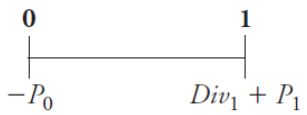

*Figure 15 – One-year investment horizon – **Source:** Berk & DeMarzo, Corporate Finance*

In the previous picture, it is shown a one-year investment. The investor buys the share at P_0 and holds it for a year. In that year, he is assumed to receive dividends. Moreover, the

investor will sell the shares, after the holding period, for a price P_1. Of course, Div_1 and P_1 are not known a priori by the investors. They are based on his expectations. For this reason, the investor is willing to purchase the stock only if:

$$P_0 \leq \frac{Div_1 + P_1}{1 + r_E}$$

In other words, the investor is willing to purchase the stock today only if the price he pays is lower than the present value of his expected benefit deriving from dividends and increased in the share price, also called a *capital gain*.

Notice that the uncertainty around Div_1 and P_1 makes the investment risky; thus, the cash flow can not be discounted at the risk-free rate but instead at the equity cost of capital.

The oppositive happens for an investor wishing to sell its share. He expects to sell it for a higher return compared to what he paid at t_0:

$$P_0 \geq \frac{Div_1 + P_1}{1 + r_E}$$

In conclusion, these two equations must hold, stating that both the activities as buying or selling shares have a NPV that is equal to zero if markets are competitive:

$$P_0 = \frac{Div_1 + P_1}{1 + r_E}$$

Rearranging the formula (multiplying by $1 + r_E$, dividing for P_0 and subtracting one from both the sides) it is expressed that the return on equity must be equal to the total return an investor is willing to get. The total return equals the sum of the dividend yield and the increase in the stock price.

$$r_E = \frac{Div_1}{P_0} + \frac{P_1 - P_0}{P_0}$$

In other words, the investors expect a total return that is equal to the possible return they can obtain from other investments having the same risk.

The same reasoning already saw, can apply for a two-year horizon investment; in fact, the price of the stock today would be:

$$P_0 = \frac{Div_1}{1 + r_E} + \frac{Div_2 + P_2}{(1 + r_E)^2}$$

The one-year investor and the two-year investor evaluate the stock in the same way. In fact, for the two-year investor, P_2 and Div_2 are more important than the ones in year 1. Also, they are more critical for the one-year investor because they will affect its gain deriving from the selling of his share. In fact, the buyer to which the one year investor will sell the share, is willing to buy it for the following price:

$$P_1 = \frac{Div_2 + P_2}{1 + r_E}$$

Indeed, the DDM is based on substituting the last stock price with the next buyer's price leading to the extension of this model to N periods.

$$P_0 = \frac{Div_1}{1 + r_E} + \frac{Div_2}{(1 + r_E)^2} + \cdots + \frac{Div_N}{(1 + r_E)^N} + \frac{P_N}{(1 + r_E)^N}$$

The conclusion is that the investors evaluate stocks in the same manner without considering the investment horizon. Moreover, theoretically, an investor can hold the security up to infinity, allowing the following arrangement of the formula:

$$P_0 = \sum_{n=1}^{\infty} \frac{Div_n}{(1 + r_E)^n}$$

In other words, a stock is valued based on the expected dividend it will pay to its stockholders discounted at the cost of equity.

The first drawback of this method is the forecasting of dividends. For this reason, some assumptions can be made, such as the constant growth rate of dividends, g. In this case, the price of the stock can be obtained using *the constant dividend growth model*.

$$P_0 = \frac{Div_1}{r_E - g}$$

From the formula, it is clear that to increase the share price, the company should increase the dividends or the growth g, leading to a trade-off. In fact, to increase g, companies must reinvest money instead of paying dividends to investors.

The previous formula can be rearranged in the following way, expressing that the constant growth of dividends, g, is the same as the capital increase deriving from the share price increase.

$$r_E = \frac{Div_1}{P_0} + g$$

There are three possibilities to increase the dividend level. One option consists of increasing the EPS that can be achieved by increasing earnings or decreasing the outstanding shares. The last alternative is identified in the increase of the dividend payout ratio: the amount of earnings distributed as dividends. These considerations can be observed in the following formula.

$$Div_t = EPS_t \times DPR_t$$

The reasons why earnings can grow can be seen in the next formula.

$$Growth\ rate\ of\ earnings = \frac{change\ in\ earnings}{earnings}$$
$$= retantion\ rate \times return\ on\ new\ investment$$

The retention ratio is the amount of earnings that the firm reinvests in its business instead of distributing them as dividends.

$$g\ (sustainable\ growth) = retantion\ rate \times return\ on\ new\ investment$$

Sustainable growth is the level of growth a firm can achieve by only deploying retained earnings to grow.

The assumption of the constant growth of earnings holds only for mature firms. Contrariwise young firms use to increase earnings at a higher speed initially, invest them in the business without paying dividends, and have constant earnings only when they reach maturity. With those firms, the constant dividend growth model can be used only from the maturity phase.

3.2.3. Total payout model

(Berk & DeMarzo, Corporate Finance, 2016) This model is a variation of the DDM model, and it is easier to compute when the firm repurchases shares. This model does not distinguish between dividends and share repurchase. Dividends and share repurchases are two indifferent ways to return profits to investors. The difference between the two possibilities is that, in a share repurchase, tax is deferred until the moment in which the share will be sold.

In the dividend discount model, the share price is calculated by discounting the dividends a single shareholder receives:

$$P_0 = PV\ of\ future\ dividends\ per\ share$$

Instead, the share price is calculated considering the whole payout without distinguishing dividends or buybacks in the total payout method. It is a way to estimate the value of the entire equity of the firm. The result must be divided by the number of shares.

$$P_0 = \frac{PV\ of\ future\ totalal\ dividends\ and\ repurchases}{shares\ outstanding_0}$$

3.3. Net Asset Value or Sum-of-the-parts Method

(Quiry, Dallocchio, Fur, & Salvi, 2018) The NAV method is mostly used for small companies or for companies owning assets which are easy to be valuated, due to their presence on a secondary market. Moreover, it is also deployed by firms that are highly diversified or that are conglomerates. In this case, the different groups belonging to a firm are evaluated using the DCF or the multiples using comparable firms. Firstly, the method's idea is to assess the assets' value; then, values must be adjusted or revaluated. Assets on the balance sheet can be very different from their real value. The same process has to be carried out for liabilities. In the last stage of the process, the value of liabilities will be subtracted from assets' value. For this reason, it is generally referred to as an *additive method*.

The first complication of this method is that the type of value of assets and liabilities must be coherent. Usually, three kinds of values can be used in the NAV method. The first one is the so-called *market value,* which is the price for which the asset can be sold. Another type is identified in the *value in use*: value deriving from the company's operations using that particular asset. The last one is the *liquidation value* that is generally lower than the market value. (Berk & DeMarzo, Corporate Finance, 2016) In fact, a way for a company to avoid bankruptcy is the sale of assets, called a *fire sale of assets*; it is a process in which the company expects to sell assets in a fast way in order to be able to raise money, by lowering the actual price of the assets. The fire sale is mostly used in the sale of subsidiaries, in which the "parent" company wishes to sell the "daughter" company.

(Quiry, Dallocchio, Fur, & Salvi, 2018) The idea behind the valuation of tangible assets is not to evaluate single assets but a group of assets for which it exists a market.

Inventories are easily valuable except inventories owning obsolete products (a discount must be applied) or having lengthy production rounds for which a revaluation has to be made.

A more difficult task is identified in the valuation of intangible assets such as brand, patents, or lease rights. Moreover, it is also the most critical activity to be carried out given

that, nowadays, the largest part of a company's value is generally represented by intangible assets. Three valuation processes can be deployed to evaluate brands or patents.

The first one is to understand the effort needed to rebuild the brand in terms of advertising expenses. The downside of this method is that established brands that are failing might be overvalued. Conversely, younger and promising brands may be valued below fair value. Another way can be identified in summing the royalties deriving from the use of the brand from third-party companies, discounting it to obtain the present value. The last method is the analysis of the utility deriving from the use of the brand name. In other words, this method is aimed at determining the so-called *excess profit*. The *excess profit* is calculated as the difference between the company's profits using the brand that can sell products at higher prices and a company that sells similar products without using that brand. Like the other methods, the excess profit is discounted to identify the present value.

Instead, to evaluate lease rights, a difference between the company's rentals and the rents the firm has to pay is calculated and then discounted.

3.4. Valuation methods comparison

The three different valuation methods' results can be different one from another; the valuation methods are not an exact science. Still, very often, they are not the same, and the analysis of the source of the differences must be initiated. The explanation of the possible sources of differences deploying the DFC and the sum-of-the parts method is outlined in the table below.

Difference	*Explanation*
Value obtained with Sum-of-the-parts method > Peer evaluation or DCF	Instead of investing, the company should divest because it has been valued more for its past than for its future profitability.
Value obtained with Sum-of-the-parts method < Peer evaluation or DCF	It is the case that occurs the most due to the high amount of companies' intangible assets (such as expertise, bargaining power, barriers to entry, etc.). The company invests in profitable projects gaining a higher return than the cost of capital. The goodwill must be estimated to reflect the value of intangibles.

Table 16 – Explanation of why the result is different using different evaluation methods

In the following table, instead, are analyzed the sources of differences in the result obtained with peer comparison and DCF method.

Difference	*Explanation*
Value obtained with Peer Comparison > DCF value	It is the right moment to start an IPO because investors in the financial markets are more optimistic about the firm's future compared to the existing shareholders.
Value obtained with Peer Comparison < DCF value	It is not the right timing for an IPO; it is better to wait or transform a company from public to private.

Table 17 – Explanation of why the result is different using different evaluation methods

Moreover, companies' lifecycle can also be a reason to show different results among the valuations methods, summarized in the next table. This is due to substantial difference from the net asset's value and the CF value.

Difference	*Explanation*
Foundation stage	Before the company undertakes investments, the same cash flow value and sum-of-the-parts value can be observed. After the first years, the cash flow value might be higher due to the optimistic forecast of future profitability. The sum-of-the-parts value might be lower due to possible losses.
Growth stage	In this stage, both the net assets value and the cash flow value increase but the net assets value increases less than the cash flow value. It happens because the company starts having valuable intangible assets as the creation of a customer base. However, it is still too early to consider expertise as a tangible asset.
Maturity stage	In this stage, both the net assets and the cash flows value start to decrease; they are very close. The former because of the increase in the payout ratio (generally in the maturity phase, companies start paying dividends to investors while in the early phases, they usually prefer to reinvest the earnings in the business to allow a faster growth) and the latter because it starts showing a normal trend for profits.
Decline stage	In the decline stage, the cash flow value is below the NAV. The assets value increases very slowly until it reaches the point in which losses are exposed and starts declining. Then it becomes speculative.

Table 18 – Differences in valuation methods deriving from the lifecycle of a firm

The considerations listed in the previous table can be directly observed in the next chart:

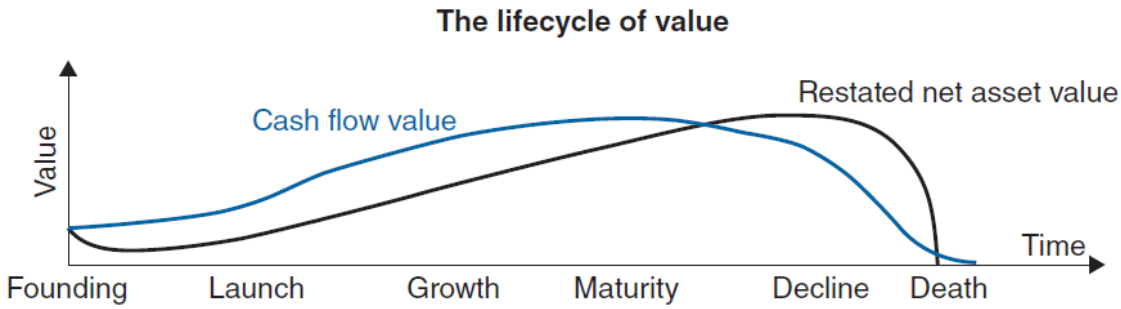

*Figure 16 – Lifecycle value – **Source**: Quiry, Dallocchio, Fur, & Salvi, Corporate Finance*

CHAPTER 4 – Biotech Valuation

4. Overview of Biotech valuation

Valuating a Biotech company is not an easy task because the previous chapter's traditional methods are not suitable. Assess the value of a company also means considering the market and the management that comprises it. For this reason, this chapter will firstly analyze which companies can be nominated "Biotech"; secondly, it will examine the most important events characterizing the market of Biotechnology (schematized in the timeline that will follow); then, it will focus on the differences between traditional companies and biotech companies to understand which methods can better suit the industry.

4.1. Biotech companies

(OECD, 2018) *The Organization for Economic Co-operation and Development* (*OECD*) defines, in the annual statistical report, Biotech as the application to living organisms, or parts of them, of science and technology, intending to alter living and non-living materials to produce knowledge, or goods and services. Moreover, the OECD classified as a biotechnological company, a firm that is operating in one or more categories that follow:

1. *DNA/RNA;*
2. *Proteins and other molecules;*
3. *Cell and tissue culture and engineering;*
4. *Process biotechnology techniques;*
5. *Gene and RNA vectors;*
6. *Bioinformatics;*
7. *Nanobiotechnology.*

Biotechnology can be divided into several sub-categories to identify the fields of application:

- *Red biotechnology* is applied in the medical field; it stands out for its genome studies. Its primary application is *innovatively designing a drug* to allow the medicine to reach the target while avoiding the immune system's attack. Another application can be identified in *gene therapy,* where recombinant DNA is used. A gene is inserted into a patient's cells to counterbalance or possibly eliminate the allele that causes the disease;

- *Green biotechnology* is applied in the field of agriculture. Some applications can be found in the *synthesis of biofertilizers and biopesticides*, whose purpose is to limit the environment's impact while maintaining traditional effectiveness. Applying biotechnology to crops can also make farming more attractive to the market as it can increase pest resistance and increase storage times.
- Instead*, White biotechnology* defines industrial biotechnologies that use biology to produce a commercial or mass consumer product. This type of biotechnology is mainly used in sectors such as food, energy, cosmetics, etc. The basic principle is that enzymes require mild operating conditions, guaranteeing savings in time and money by not harming the environment through the use of little water and avoiding the production of polluting waste.

4.1.1. Trends

Typically, biotech companies can follow three paths aim at raising money for the research and development stage.

The primary trend is licensing out the drugs they have discovered to a big pharma company. Licensing is a way to benefit both the biotech company and the big pharma firm from the complementarity of their capabilities. In fact, the former lacks the skills to market and distribute a drug; however, it generally has innovative products. On the other hand, a big pharma possesses the marketing and distribution capabilities but often lacks highly innovative products in its pipeline. For this reason, licensing can be seen as an excellent alternative to favor both sides.

Another possibility for a biotech company to raise money can be seen in M&As. The biotech firm becomes the target company, and the big pharma company buys it. Once again, also M&As are completed due to the complementarities of capabilities of the two companies. In fact, the Big Pharma firm usually has a large cash reserve that the biotech firm does not have and is willing to pay a premium price to acquire the Biotech Firm. The benefit of a biotech company to conclude a M&A is the increase in shareholders value.

A biotech firm's last possibility is to get listed on a stock exchange and raise money with an IPO. This way, the company will be able to carry on its drugs to market on its own. Obviously, initiating the IPO process is costly, and only the biggest firms can go through it.

A biotech company can be backed by V.C.s that provide funds for developing a drug, while also taking the risk and by big pharma companies interested in its innovations. There is a sort of competition between V.C.s and big pharma firms, which is the main ingredient to help the company valuation.

A strong implication is that, normally only bigger size firms will incur the IPO process; the other firms will choose one from the other ways of financing. Thus, the IPO volume normally is lower than the amount of the alternative financing. We can have an idea about this statement by looking at the next chart showing the situation of Biotech firms in the UK (Hopkins, Crane, Nightingaley, & Baden-Fuller):

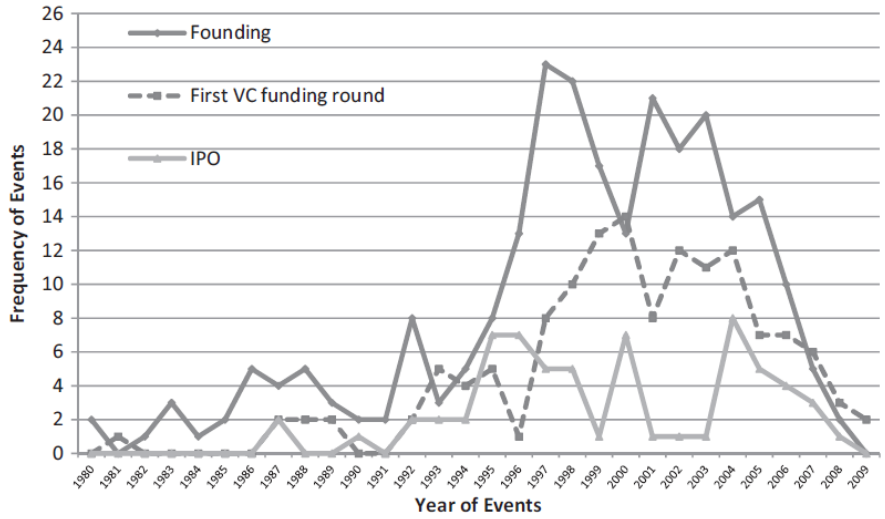

Figure 17 – IPO or VC funding, ***Source****: Buying big into biotech: scale, financing, and the industrial dynamics of UK biotech, 1980–2009, Hopkins, Crane, Nightingaley, & Baden-Fuller*

Moreover, it is important to focus on past patterns, concerning the alternatives methods. It is noticeable that the number of Biotech IPOs change during the years. It does not follow a trend (**Fig. 18**). The same consideration does not apply to M&A. In fact, over the years, the M&A of Biotech firms is increasing (**Fig. 19**).

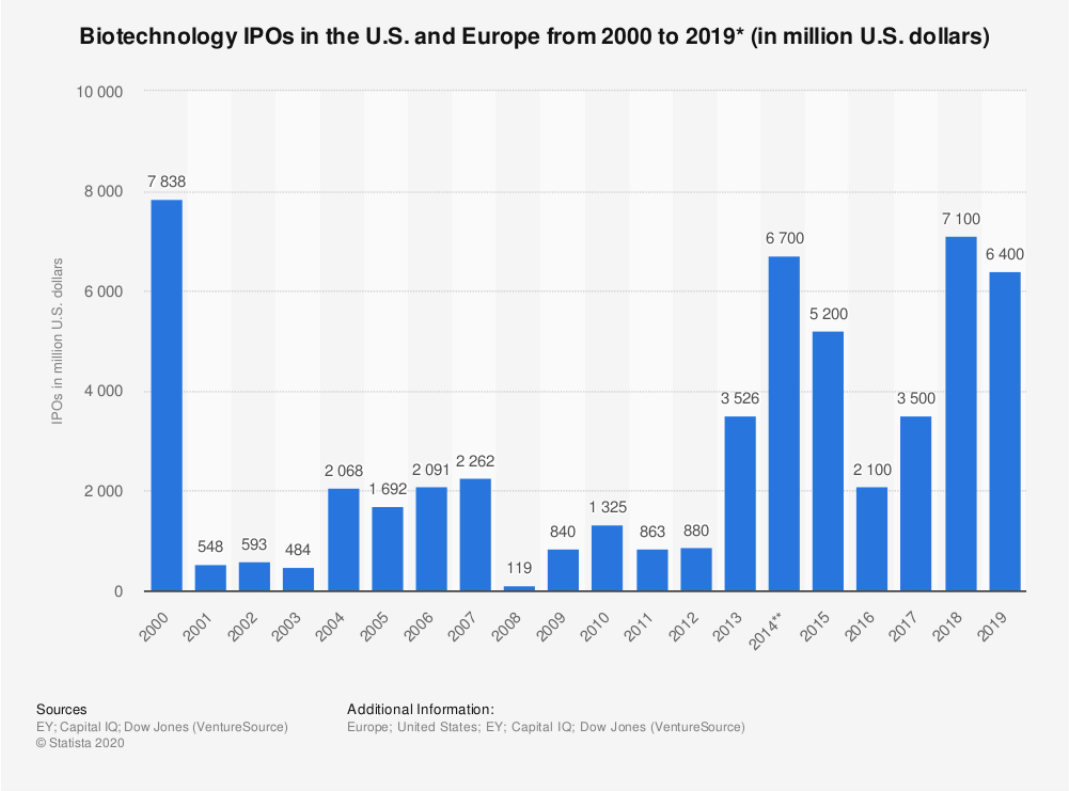

Figure 18 – Biotech IPO: ***Source****: Biotechnology IPOs in the US and Europe from 2000 to 2019, Statista*

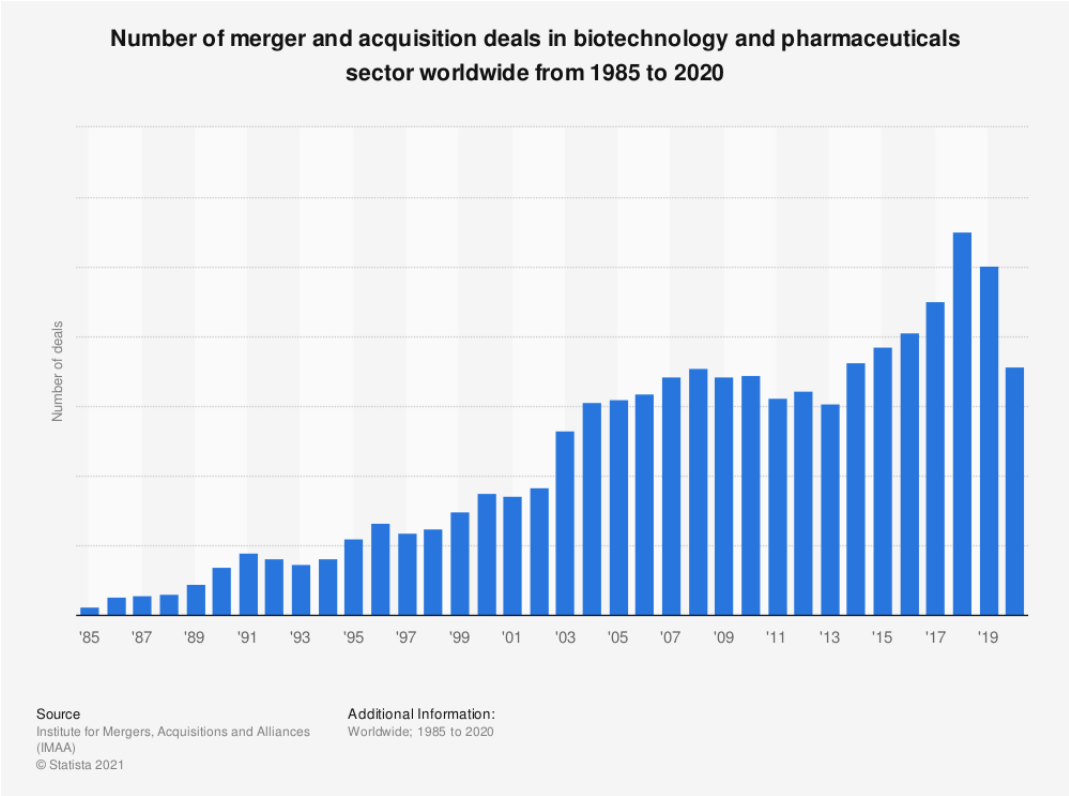

Figure 19 – Biotech M&A: ***Source:*** *Number of Merger and acquisition deals in biotechnology and pharmaceuticals sector worldwide from 1985 to 2020, Statista*

The choice of the financing method for what concerns Biotechnology firms, does not depend only on the size of the company but also on the stage in which the company is and on the area in which the company is developing the drug (Doug & Mark, 2005). The next two charts analyse this consideration.

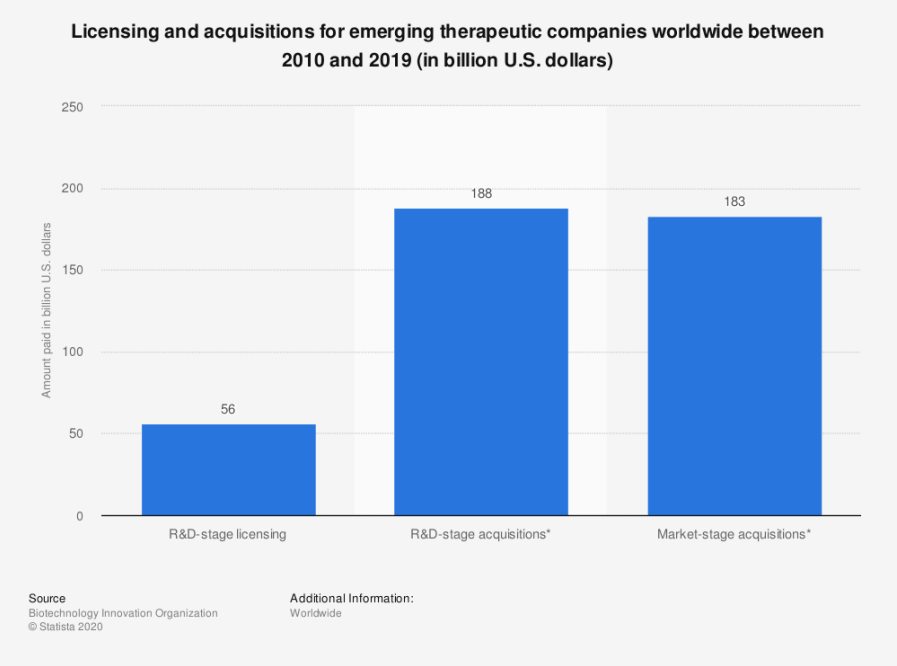

*Figure 20 – Biotech Licensing and Acquisition by stage – **Source**: Licensing and acquisitions for emerging therapeutic companies worldwide between 2010 and 2019, Statista*

From the previous chart, it can be observed that, normally biotech firms initiate a merger and acquisition for an R&D stage or directly a market stage. In the early stage, they are financed by VCs.

(Doug & Mark, 2005) Since 1979, pension funds have been able to invest in VC funding. 50% of VC funds today is represented by pension funds, in the United States. 1981 was the year of the **Economic Recovery Act** which gave a further boost to VC funds as taxes on individual capital gains dropped from 42% to 20%. Thanks to this Act, the VC fund for biotechnology has increased from 43 million $ in 1980 to 542 million $ in 1983. VC financing of Biotech companies has continued to grow, reaching 4.8 million billion in 2000.

The Biotechnology industry and the VC industry are less developed in Europe than in the United States because in Europe, the sector has only started to grow since the 1990s. The European country in which VC companies invest more in Biotechnology is the Germany (28% of VCs invest in Biotech).

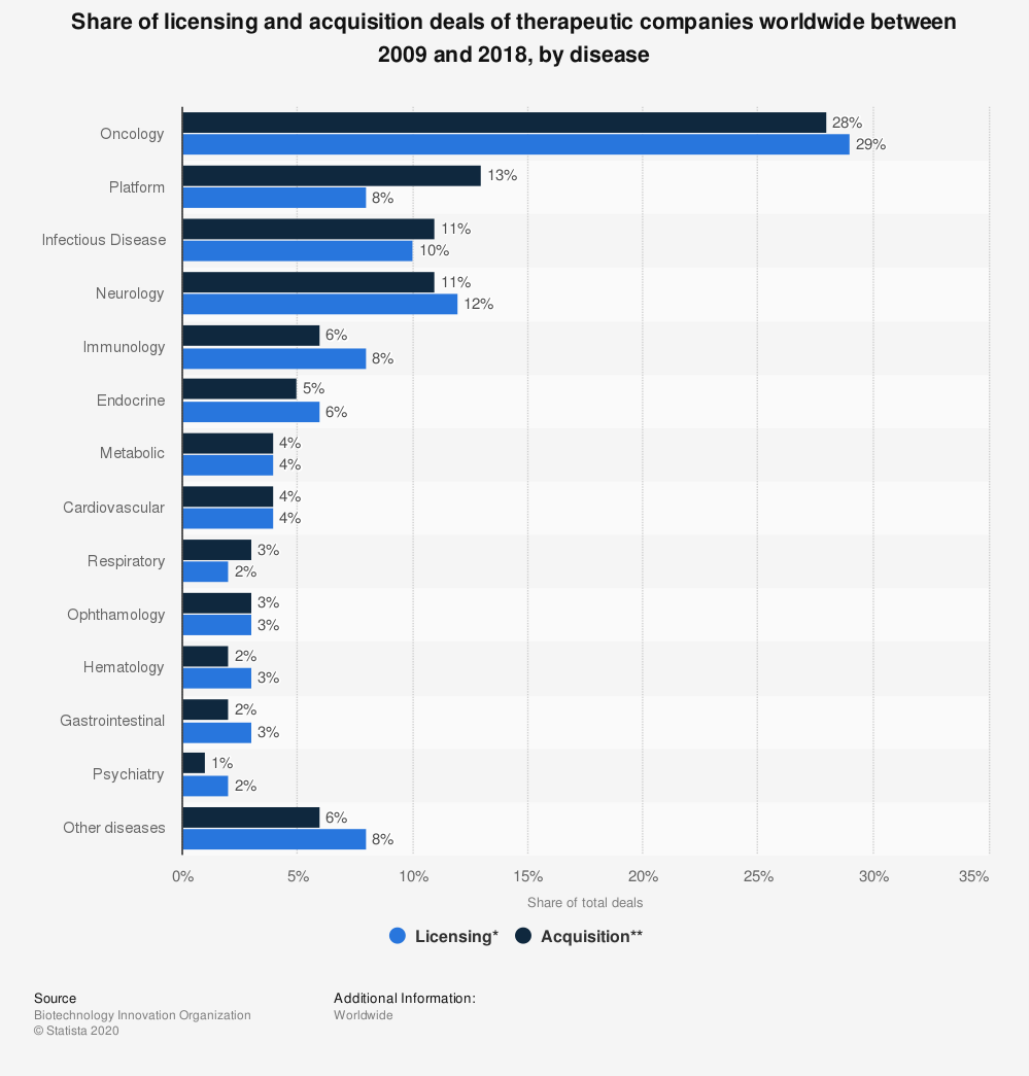

*Figure 21 – Licensing and acquisition grouped by area – **Source**: Share of licensing and acquisition deals in therapeutic companies worldwide between 2009 and 2019, Statista*

4.1.2. Differences

4.1.2.1. The risk

The biotech sector is an industry entailing high returns; therefore, high risk. The process from discovering a drug to approval is lengthy and costly (on average, 2,5 billion dollars are spent to complete it). Thus, it brings uncertainty around the investment;

(Kallmeyer & Canabou, 2001) states that, on average, only one drug over 5000 reaches the FDA approval and that the average cost necessary to develop a drug is higher than 500 million dollars. Besides, the article specifies that FDA approval is not synonymous with profitability. In fact, it cites a study from Duke University in 1994 which shows that only 3 out of 10 medicines, after approval, have had enough returns to cover the cost of R&D. The risk in the eyes of investors is reduced if the company can count on several patents, mainly for two reasons. First, if the drug fails to gain approval, the company

will still have the patents and might retry the creation of other medicines as long as they fall within the patent scope. Second, patents can be highly effective in blocking competitors trying to create the same drug.

Moreover, every stage of the development process can entail a significant probability of failing. If the drug fails in one stage, the process is irreversible. Hence, the risk is different than in other sectors. (Golec & Vernon, 2007) proved that the systematic risk that cannot be eliminated through diversification is more significant for firms belonging to the biotechnological sector because the sector is susceptible to policy shocks affecting its profitability. The systematic risk is what matters for companies, given that the cost for R&D financing depends on it. The Biotech industry is an R&D-intensive sector; R&D intensity is the R&D expenditure over total assets.

4.1.2.2. The long development cycles and approvals

(FDA, 2018) The steps that scientists must follow to develop a drug and subsequently submit it for approval by the FDA are schematized in the following table. The FDA is the American entity responsible for certifying medical products such as drugs, vaccines, or medical devices. Understanding the development process is a fundamental task in evaluating a Biotech firm; Moreover, it is crucial to know the stage of development in which a drug is because it is strongly related to the degree of risk implicit in the firm.

Step	Explanation
Discovery and Development	The step begins with identifying numerous compounds by the researchers and ends with selecting some candidates from the ensemble after the implementation of tests and verifications.
Preclinical Research	The keyword in this step is toxicity. It can be assessed through *in **vitro** tests* (trials in artificial environments) or *in **vivo** tests* (in live settings). It is a step aimed to discover the overall effects and possible side effects.
Clincal Research	It is the most crucial stage because, after testing a drug's safety, it focuses on the interaction a candidate drug can have on the human body. Before starting the clinical research stage, scientists have to submit to FDA the results obtained through tests in animals, called the ***Investigational New Drug*** process. Given that the clinical research stage is an essential step for evaluation purposes, it will need further explanation (discussed below).
FDA Drug Review	Researchers must fill a ***New Drug Application*** (NDA) with all the results deriving from the previous phases, and then, the FDA will evaluate it and decide whether to accept it in less than ten months or reject it.
FDA Post-Market Safety Control	This stage is essential in evaluating the drug's safety in the long term by considering the overall effect on people tested.

Table 19 – Drug development process

For what concerns the **clinical stage**, it is composed of more steps entailing different probabilities of surviving to the next step, schematized in **Fig. 22**. The figure also shows the number of people that must be tested and the time required for each phase. After the braces, the objectives of each step are reported.

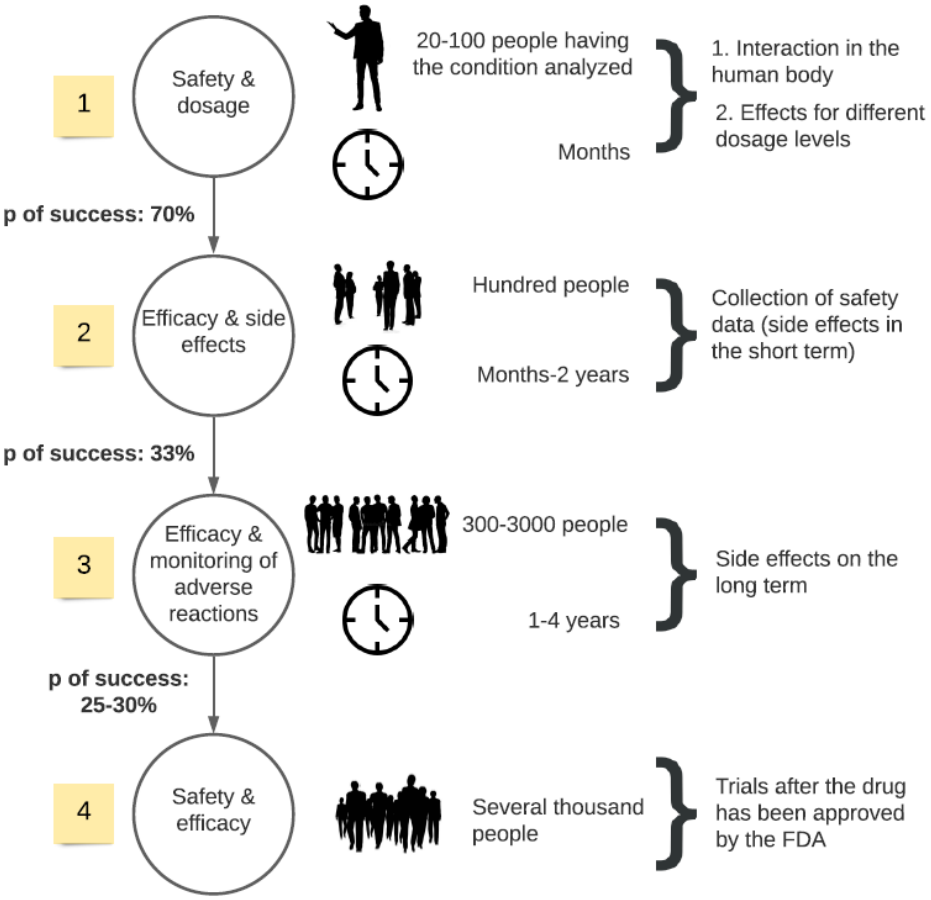

Figure 22 – Clinical Stage Steps

Under certain conditions, such as an epidemic situation, the FDA authorization process can be further simplified by issuing an **Emergency Use Authorization**. In this way, the medical product's approval will be faster, balancing the risks and benefits of the data currently available without waiting for further evidence that can only be gathered over time.

(The Scientist, 2020) In terms of information disclosed and economic value of the drug tested, the Emergency Use Authorization can lower the standards. In fact, an Emergency Use Authorization expresses that the drug "may be effective" while the normal process of the FDA tests the real effectiveness of the drug. It can also happen that the FDA later on, revokes the EUA previously issued.

4.1.2.3. No earnings

A difference between a biotech company and a mature healthcare company is that the former pays no dividends basically because it has little earnings; the earnings are re-invested in research and development. Biotech investors can only earn from a rise in the share price, while investors in mature healthcare companies can expect dividend earnings

as well. Biotech companies may also have high revenues (intended as total proceeds from the sale of products) but usually have meager operating profit (intended as revenue after operating expenses required to run operations are accounted for), shown by Harvard Business Review **Fig. 23**.

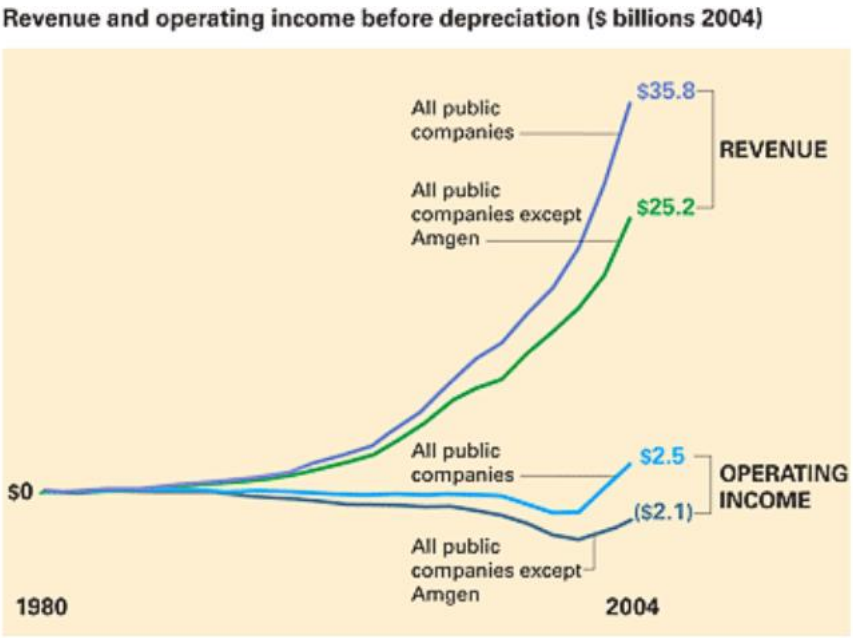

*Figure 23 – Operating income and Revenue of Biotech Firms – **Source**: Can Science Be a Business? Lessons from Biotech, Harvard Business Review*

As biotechnology is an R&D-intensive sector, research and development costs are very high. Most of the R&D expenditure are originated from clinical trials, as shown in **Fig. 24**.

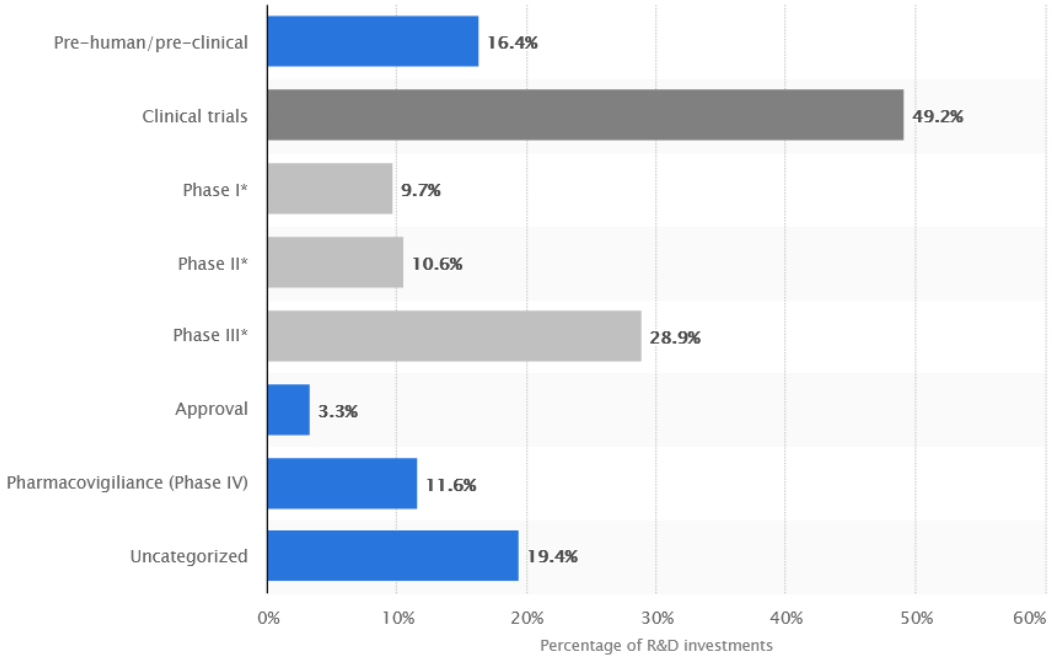

Figure 24 - Allocation of research and development investments – Source: ***Allocation of research and development investments in pharmaceutical industry in 2018, by function,*** *Statista*

4.1.2.4. Reduced asymmetric information

It is common to think that the most valuable assets of Biotech companies are intangible ones that are also very difficult to be evaluated. Moreover, other common beliefs are that under-pricing increases with asymmetric information, stated in Chapter one and that assessing intangible assets brings a high level of asymmetric information.

(Re-Jin, Lev, & Zhou, 2005) proved that, contrary to all expectations, Biotech's underpricing is lower (on average 13%) compared to traditional IPOs (average 20%); this statement will be analyzed empirically in the next chapter. A possible explanation of a lower underpricing level can be identified in the reduction of the asymmetric information degree thanks to the comprehensive description in the prospectus of all the patents owned by the firm and, more in general, of all the intellectual properties possessed.

4.1.2. The Market

The timeline described in the table below tries to explain the market that characterizes this sector. For this purpose, the most important deadlines are analyzed, grouped by market. Some years require further explanation and will be discussed below the table.

USA	2000	- Draft Human Genome; Investors attracted by genomics (availability of information lacking in the past); - Some Biotech companies start to profit, increasing the credibility of the industry; Investors accepting high risk to invest in dot-com firms, also start investing in Biotech, adapting to market volatility;
	2004	- Completed the sequencing of many genomes;
	2009	- Release of **federal funds** approved by the Obama administration for the study of stem cells; Approval of embryonic stem cells in clinical trials by FDA;
	2010	- **Patient Protection and Affordable Care Act** (Some provisions need to be implemented; the results will only be seen over the years); Direct and Indirect incentives to boost the innovation of Biotech SMEs;
	2014	- Start of the consolidation period of Italian biotech companies (stable number of companies); Negative economy that does not help innovation; 0 Italian Biotech IPOs; Focus on Oncology;
	2016	- Low Nasdaq Biotech Index; Low number of IPOs; Low approvals rate from FDA; Investors fear that the high price of drugs is not sustainable; - 13th December 2016: **21st Century Cures Act** (Technological improvement of FDA approval procedure; FDA evaluates drugs using analytics and the real world experience);
	2017	- Modern & Flexible regulation environment ; High number of approvals from FDA; Increase in the competition level (more players, reduction of drugs prices); - Focus on Gene Therapy; Approval of the first retinal gene therapy by FDA;
Asia	2018	- Hong Kong listing reform;
Europe	2019	- Year of Renaissance of EU biotech companies (new investors such as private equity, family offices, sovereign wealth funds); - Increase interest of Chinese investors (benefited by the USA-China commercial war);

		- Migration of Eu Biotech companies to the NASDAQ to raise fast money while remaining competitive, & to attract crossover investors;

The year 2000 can be seen as the Biotech sector's real start even though the first Biotech IPO was held in San Francisco in 1980. Suffice it to say that in 1980 and 1990, the IPOs could not raise more than 20-30 million dollars. Since 2000, a window has opened in Biotech that can be linked to the diminishing profits of dot-com companies and studies on the human genome that have begun to attract investors' attention. Investors who had become accustomed to the volatility of the internet market became interested in Biotech. Also, in 2000 there was the first Biotech IPO, Tularik, capable of raising $ 100 million, which was the first of a series of IPOs.

(Milne & Kaitin, 2010) 2010 was the year of the "*Patient Protection and Affordable Care Act*" impacting directly and indirectly on Big Pharma companies and Biotech startups (see **table 20**). These two entities should not be seen as separated bodies. In fact, almost 25% of Biotech startup revenues derive from Big Pharma companies.

Consequences on Big Pharma companies	Impact on Biotech SMEs
- Increase in sales volume, given by the entry of 32 million citizens who previously did not have insurance.	- SMEs have 12 years of data exclusivity for their drugs to offset the incentives given to biosimilars.
- Increase in competition due to provisions trying to expand the market of generics and biosimilars.	- SMEs with less than 250 workers are granted 1 billion dollars of a tax credit for research activities expenses.
- Big pharma companies must reduce drug prices or give patients discounts to counterbalance the sales volume increase.	- Biotech SMEs are highly innovative; thus, they dominate the orphan drug market (a segment that needs innovative drugs and fast approvals). In the Act there are provisions to boost innovation in this segment, for example, granting tax relief and the priority of approvals by the FDA.

Table 20 – Comparison between Big Pharma Companies and Biotech SMEs

(Assobiotec Federchimica & ENEA, 2018) For what concerns Italian Biotech Companies, instead, from 2014 it has started a period of consolidation. In fact, the number of companies has remained stable over time. The consolidation phenomenon can be seen in **Fig. 25**.

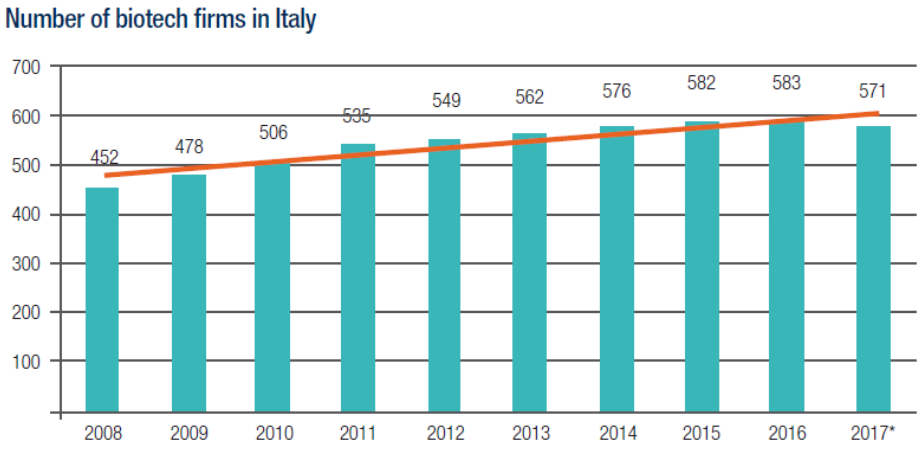

Figure 25 – Consolidation of the Italians Biotech Companies – Source: ***The Italian Biotech Industry Facts & Figures,*** *Assobiotec Federchimica & ENEA*

Moreover, in that year, the primary source of financing for Biotech was self-financing. It is noticeable that zero IPOs have happened, probably because of a period of negative economy and weak stock markets.

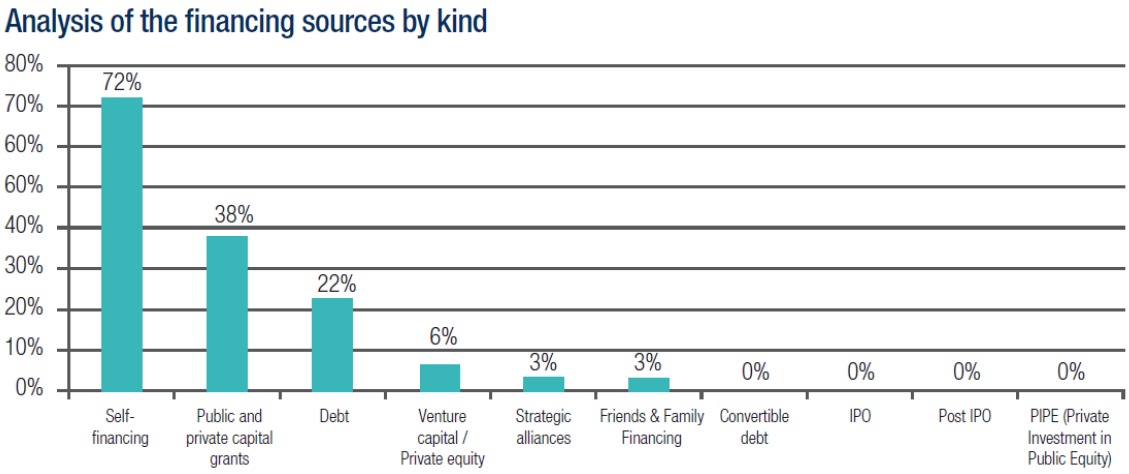

Figure 26 – Origins of Italian Biotech Companies funding - Source: ***The Italian Biotech Industry Facts & Figures,*** *Assobiotec Federchimica & ENEA*

It is important to notice that, in Italy, the number of Biotech firms is still very small. In fact, the number of Biotech companies in 2019 was only about 600 firms. For further statistics, see the next table, reported from The Italian Biotech Industry Facts and Figures.

	Total number of companies	*Dedicated biotech R&D firms…*	*of which, nationally controlled dedicated biotech R&D firms*
Number of firms*	696	365	344
Biotech turnover**	12,053,180	4,909,185	975,153
Total R&D investment**•	2,262,564	531,741	242,392
Total biotech R&D investment**•	777,534	490,063	231,385
Biotech employees**	13,313	6,087	4,176
Biotech R&D employees**	4,526	2,899	1,913

Values in thousands of euros €/000

*Last available data, 2019 **Last available data, 2018 •Intra-muros and extra-muros total

Table 21 – Key figures of the Italian Biotech Market - Source: ***The Italian Biotech Industry Facts & Figures****, Assobiotec Federchimica & ENEA*

Moreover, Biotech firms in Italy are mainly micro or small firms.

	2014	2015	2016	2017	2018	2019
Micro	62.5%	62.4%	63.8%	62.9%	61.6%	61.8%
Small	15.5%	16.2%	15.9%	16.6%	18.1%	18.1%
Medium	12.3%	12.2%	11.7%	11.9%	12.0%	11.8%
Big	9.7%	9.2%	8.6%	8.7%	8.3%	8.3%

Table 22 – Size of Italian Biotech Firms – Source: ***The Italian Biotech Industry Facts & Figures****, Assobiotec Federchimica & ENEA*

(Morrison & Lähteenmäki, Public Biotech in 2016 - The Numbers, 2017) 2016 has not been an excellent year for Biotech. The main reason was the concerns of the non-sustainability of high prices of drugs in investors' eyes. This is visible in the next chart showing that the Nasdaq Biotechnology Index increasing trend stopped in 2016.

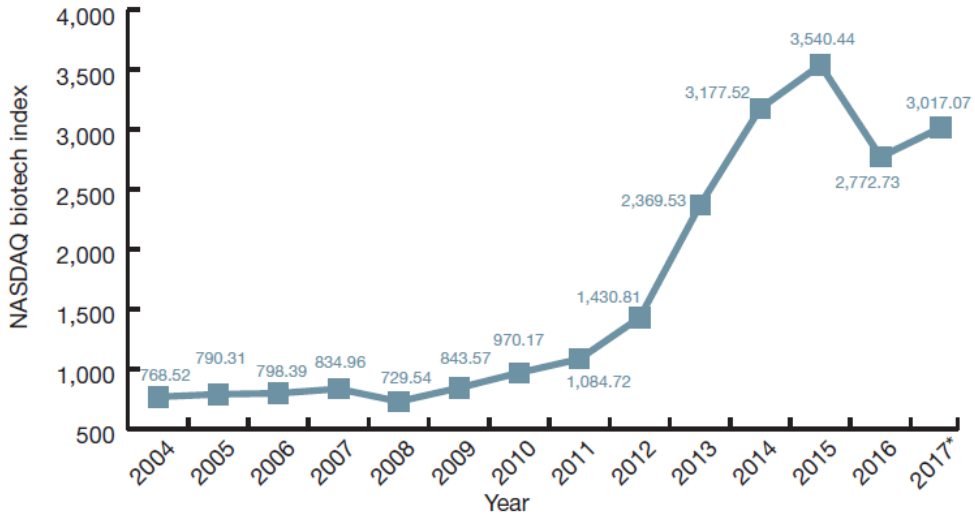

*Figure 27 – Evolution of the NASDAQ Biotech Index - **Source**: **Fresh from the biotech pipeline-2017**, Morrison*

(Morrison, Fresh from the biotech pipeline-2017, 2018) expressed that 2017 has been an innovative year for Biotech for many reasons. In fact, the first gene therapy to cure a retinal disease has been approved by the FDA that year. Moreover, the industry's competition increased in 2017 due to new players entering the market and, more importantly, more approvals by the FDA due to the *21st Cures Acts* enacted on December 13, 2016. For this reason, approval rates have grown faster than in the previous year, with 49 novel drug approvals compared to 22 approvals in 2016. Many drugs rejected in 2016 have been approved only in the next year.

(FDA U.S. Food and Drug Administration, 2020) The *21st Cures Acts* made it possible to increase the speed of drug discovery and development. The law is aiming at simplifying the evaluation process by the FDA. Two programs refer to this law. Specific categories of biological products can be accepted more quickly, thanks to the program called *Advanced Regenerative Medicine Therapy,* or *RMAT*. The drug this program refers to must be a regenerative medicine therapy[17] that treats a serious condition and shows evidence for treating an illness that is not yet resolved. Moreover, there is another program to speed up the development process of specific medical devices[18] to guarantee treatment for patients

[17] Defined by the FDA as <<a cell therapy, therapeutic tissue engineering product, human cell and tissue product, or any combination product using such therapies or products, except for those regulated solely under Section 361 of the Public Health Service Act and part 1271 of Title 21, Code of Federal Regulations>>.

[18] The device falls into the above category if it provides more effective treatment for extreme conditions or if it meets at least one of the following criteria:

1. it is a Breakthrough Technology;
2. there are currently no approved alternatives;

with severe conditions in the shortest possible time, nominated as the *Breakthrough Devices program*.

Besides, the breakthrough device program guarantees a communication channel between the device manufacturers and the FDA to meet the patient's needs and thus provide the device to the patient in the shortest possible time frame.

Also, the European Medicines Agency (EMA), similarly to the FDA, can reduce the approval process through the accelerated assessment.

On April 30, 2018, the Hong Kong stock exchange enacted the great listing reform, allowing pre-revenue companies to be listed publicly. The reform favored the Biotechnology sector; in fact, it smooths the paths for companies deriving from innovative and emerging industries. The chapter addressing Biotech in the reform is called *18A*.

(Senior, 2020) 2019 can be seen as the year of the European Biotech Renaissance due to increased interest from new investors, such as:

1. *Private equity investments*; P.E.'s goal is to make money by buying and restructuring companies. The investments have never been interested in Biotech in the past, as the drug development process is challenging to evaluate. In recent years P.E. have started hiring experts who can assess the process.
2. *Chinese investors*; Chinese investors are becoming more interested in European companies, above all for two identifiable reasons: the first, in the trade war with America and the second, in the excellent quality of European companies and the overvaluation of American ones.
3. *Family offices*; F.O., as P.E. have never been confident in evaluating biotech investment due to the high degree of risk and scientific knowledge needed to decipher Biotech investments. Like private equity investments, they have started hiring qualified people in the healthcare sector.
4. *Crossover investors*; many European Biotech companies migrated to Nasdaq to increasing their visibility, thus to attract crossover investors (residing in the USA) and to raise money in a fast way to maintain competitiveness.

3. it offers significant benefits to patients compared to the already approved devices;
4. its approval is in the best interests of patients with such condition.

2020 is the year of the Coronavirus outbreak, pushing up the Biotechnology funding worldwide. The financial times wrote that Hong Kong is planning to become the Biotechnological pole by 2025, overcoming NASDAQ. Hong Kong biotech listings seem to flourish due to the more significant number of **cornerstone investors** (ordinary in the Hong Kong market) who agree not to sell their shares for at least six months in exchange for obtaining a large stake, reassuring investors.

To better understand the importance of cornerstone investors it is important to read these few examples (Global Capital, 2019):

- In the IPO of Postal Saving Bank of China, that took place in the Hong Kong market, the amount of money raised is 57.6 billion HK; the number of cornerstone investors was only 6. They financed the 77% of the offering (44 billion KH);
- Xiaomi IPO raised 37 billion of HK with only 7 cornerstone investors financing 548 million HK.

4.2. Overview of biotech valuation methods

The valuation methods that can be deployed for biotech companies are summarized in the following table and are discussed more in-depth later.

rNPV	The discount rate used is the probability of success of the development stage (called the success rate).
Valuation of intangible assets	In Biotech, the most valuable assets are intangibles (patents, number of products in the development stage, number of alliances or joint ventures).
Comparable methods	In traditional firms valuations normally are used P/E, EV/EBITDA etc. Biotech companies generally have no positive earnings; thus other multiples can better fit based on total assets, number of employees, number of products in the pipeline, amount of money raised, etc.
Venture capital method	The method evaluates the exit that investors can obtain and discount it to get the present value. The discount rate for the early stages is much higher than the one in later phases.
Real Options	It is the most innovative way to calculate the value of biotech companies. The degree of difficulty is higher compared to the other methods but also the benefit.

Table 23 – Biotech Valuation Methods

4.2.1. NPV and rNPV

The shape of C.F.s in the biotech sector if often standard:

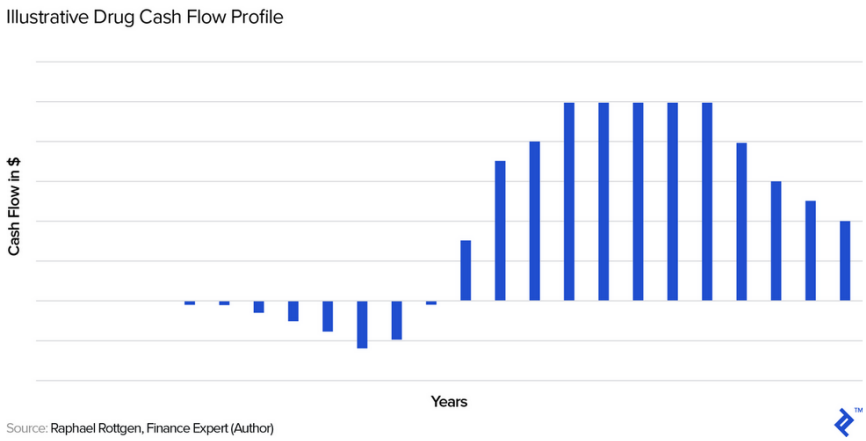

Figure 28 – C.F. shape for Biotech firms, ***Source:*** *Raphael Rottgen*

In fact, the period of analysis can be divided for the sake of simplicity into two periods, the development phase and the market phase. In the development phase, the development process is often very long, and costs are high; moreover, C.F.s are generally very negative.

In the market phase, revenue can vary depending on many drivers, such as:

- the number of patient suffering from that condition;
- the number of patients that are already being treated for that disease with a similar drug;
- the geographical areas in which the approval is effective.

The research can be made consulting, especially two websites that are:

- the Center for Disease Control and Protection;
- the World Health Organization.

Revenues generally decrease drastically when the patent expires. In fact, after that event, the drug starts to face competition deriving from generics. This means that the drug's price, once the patent has expired, will suffer a decline. The duration of a patent varies across countries, but it is 20 years on average. Moreover, the manufacturer can extend the period of protected revenues by claiming to be the **first generic manufacturer** of that drug (the protection is extended for six months in this case).

Other drivers that potentially shape the C.F.s projections are the accelerated evaluation process for specific medical products by the FDA and EMA, previously described.

Moreover, revenues originated often derive from royalties coming from licensing the drug, as seen before.

The rNPV is a modification of the DCF calculation of NPV. The risk of drug failure and the related probability of not getting to the next stage is high at the beginning of the process but decreases as the steps passed successfully. The NPV does not consider the reduction in risk because the C.F.s are discounted at a rate that represents only the overall risk. The rNPV instead takes into account the reduction, using a lower rate and multiplying the net C.F. by the probability of completing the phase in question. Therefore, the substantial difference between the two methods is the flexibility of the second in considering the risk of failure of R&D. The rNPV can be seen as the most widely used method for evaluating biotech companies, as the drug development process is extremely standardized and regulated and historical data on the success rates of the sector can be found online. NPV is calculated as the difference between discounted cash inflows and outflows for a given period. The problem arises in identifying the discount rate. Mainly two paths can be followed.

The first is the calculation of the WACC based on the stages of biotech companies. Many Biotech companies have in their capital structure no debt but only or mainly equity. The weight of the cost of equity in the calculation of the WACC will be greater. The cost of equity is calculated using the CAPM method, and as seen in the previous chapter, the expected return can be calculated from the sum of risk-free and the multiplication of risk premium by beta. In addition, beta is the investment risk and is calculated as the ratio between the covariance of investment risk and market risk on the variance of market returns. The followings are the average cost of capital for different stages of the life of Biotech companies (Stasior, Machinist, & Esposito, 2018):

- Preclinical stage: 17.7%;
- Clinical stage: 13.3-13.6%;
- Market stage: 8.7%.

The second method is based on the calculation of the rate, observing the industry benchmark. For different phases of the project, there will be different average rates that follow:

- Early-stage: 40.1%;
- Mid-stage: 26.7%;

- Late-stage: 19.5%.

To calculate rNPV it is important to know the success rate for each phase of drug development. It mainly depends on the stage of the process and the therapeutic area. R&D risk decreases as a drug continues to develop and can be summarized as follows:

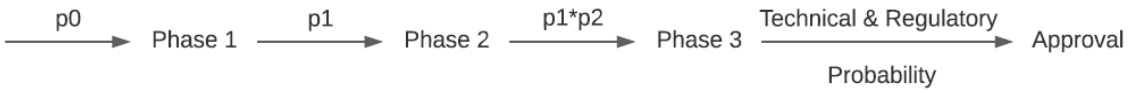

Figure 29 – Success rates in the Drug Development Process

rNPV can be calculated as follows:

TOT rNPV = P.V. of profits after the release – P.V. of costs in the process of development; thus:

$$rNPV = \sum_{t} \frac{p\ of\ FDA\ approval \times CF_t}{(1+r_i)^t} - \sum_{pt} \frac{p\ of\ success_{\ s} \times DevCost_{\ s}}{(1+r_i)^{pt}}$$

Where:

- t is the number of years until the patent expiration;
- pt is the development time of each phase;
- p of success is the probability that a drug reaches the stage s;
- DevCost is the development cost incurred in the stage s;
- C.F. are the future sales after the release;
- r is the cost of capital that changes over the different stages;

Considering that the probability of successfully entering a phase can be calculated by multiplying the likelihood of success of the previous, as shown in **Fig. 29**. It shows that the first cost incurred to enter the first stage is not weighted because it doesn't depend on the stage's success; it's a sunk cost. Then, step two's outflow depends on the probability of completing phase one; thus, it will be calculated as the probability of success of stage one times the likelihood of success of stage two.

The technical and regulatory probability that leads to the approval of a drug depends not only on the phase and therapeutic area in which the drug is but also on the drug's individual characteristics. This explains the differences that can be found between the probabilities of different industry drugs in the same area and at the same stage.

Concluding, the rNPV can be calculated by summing all the risk-adjusted C.F.s, discounted by a rate that reflects the cost of capital; the sector average cost of capital ranges from 10% to 13%.

The rNPV is more suitable than NPV to evaluate biotech companies, because the latter, does not consider the probability of drug failing during the development process. The most used method to discount future risky cash flows is the rNPV.

4.2.2. Comparable method

The comparable method was addressed in the previous chapter, and in this chapter, it will be seen in reference to the biotech sector. As said before, many biotech firms have no earnings; in fact, at least 80% of firms that are part of the Nasdaq Biotechnology Index show no earnings. Biotech companies generally have negative cash flows before their products are approved and launched on the market. In the sector, multiples such as EV / EBITDA and P / E are less suitable while E.V. / invested R&D is more relevant.

Other multiples suitable for the industry can be built based on the number of firm employees, the number of products in the pipeline, the amount of money raised, and the total assets owned.

Moreover, also the comparative valuation using public comparable or past transactions as M&A might be difficult to be applied in this sector because firms are highly idiosyncratic. The consequence is that forecasting revenue is complicated because it might not rely on comparable companies' projections. They must be built from zero.

4.2.3. Venture capital method

This method aims to determine the pre-money valuation by calculating the exit value for the investor, expecting a specific rate of return, and then discount it to obtain the present value. The approach is a DCF calculation that uses a high discount rate in the early stages of biotech companies to account for the higher risk. Its main advantage is that it is used to value pre-revenue companies or firms in the early stages, leading it to suit the biotech sector perfectly.

The expected rate of return over investment is called ROI and can be calculated in the following way:

$$ROI = \frac{Exit\ Value}{Post\ money\ valuation}$$

Rearranging the formula, the post-money valuation can be obtained:

$$Post\ money\ valuation = \frac{Exit\ value}{ROI}$$

First of all, the exit value is calculated with the help of revenue multiples, seen in the previous chapter, and it represents the value for which the firm can be sold.

4.2.4. Real options

(Quiry, Dallocchio, Fur, & Salvi, 2018) traditional methods to evaluate firms have substantial limitations. A limitation of, for example, NPV, derives from the two assumptions that must be taken. The first is the choice of future C.F. and the second is that the investment is by nature irreversible. The consequence of the second assumption is the inability of managers to expand, postpone, or abandon an investment after receiving new information. In other words, the NPV lacks flexibility. Very often, the manager has valuable options; the flexibility of the investment has a value that is not taken into account using traditional methods. The real option is an option linked to the company's assets, rather than securities such as financial options. More specifically, a real option is a right, not an obligation, to modify an investment or to make a business decision as new information has become available to the manager. Not all investments offer real options; in fact, three conditions must be met for the investment:

1. There must be some degree of uncertainty in the project; the option's value increases as the asset's volatility and, therefore, the risk increases;

2. New useful information must be available to investors during the development of a project;

3. The last condition is related to the previous one. Indeed, the information available must be useful, and the investor must also be able to modify the project after having received it.

(Berk & DeMarzo, Corporate Finance, 2016) The uncertainty in an investment can be represented using a decision tree with two kinds of nodes:

1. Square nodes (decision nodes) – representation of the possibilities available to the decision-maker in every phase;
2. Circular nodes (information nodes) – representation of the uncertainty resolution.

In the latter kind, external events can not be controlled by the person making the decision.

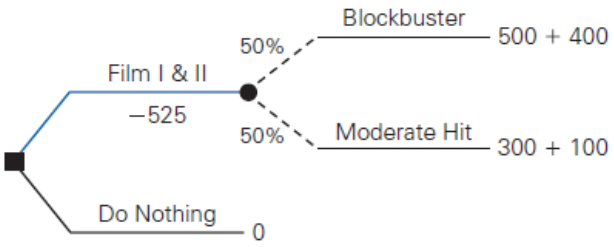

*Figure 30 – Example to show information nodes and decision nodes, **Source**: **Berk & DeMarzo**, Corporate Finance*

In the previous example, the decision-maker can not know if the product launched on the market will be a blockbuster or only a moderate hit. The approach used to solve the decision tree is to integrate backward. In this sense, at each information node, the P.V. of expected payoffs of successive branches will be computed, and at each decision node, the optimal choice will be made comparing the P.V. of payoffs that remain in each branch.

There are many types of real options, such as:

- *Option to abandon* – The abandonment option has the characteristics of a put option. Indeed, the investor can decide to leave the project if the expected payoff is less than the exercise price, which is the project's value. In other words, it is the option to quit an asset or a project and obtain the salvage value.
- *Option to expand* – It gives the right to make an investment decision in the future to expand the company's operations. It can be seen as a call option.
- *Option to delay* – It gives the right to postpone an investment decision and to undertake it in the future. The right time can add value to the investment by gathering more information, but it can also bring higher costs and new competitors' possible entry.
- *Option to contract* – It is the option that gives rights, after that some adverse conditions are met, to shut down the project. The characteristics are those of a put option; in fact, the option's value increases when the underlying asset's value decreases.

4.2.4.1. How to evaluate an option

The value of an option (if the decision tree is easily computable and all the necessary information is available) can be calculated as the difference between the NPV without flexibility and the NPV with flexibility. If this is not the case, the methods used to evaluate financial options can be suitable. The substantial difference between the financial and the

real options is that real options are not traded on the market. With real options, the underlying asset is identified in the project itself.

4.2.4.1.1. Replicating portfolio

The Replicating Portfolio method is part of the binomial option pricing model and states that the stock price can assume only two values at the end of the period. It is a method that can be used when the probabilities of the two states are unknown. In this context, the payoff of an option can be replicated using a portfolio composed of a risk-free bond and the stock (that pays no dividend) having the same payoff. The assumption that they have the same payoff implies that the option's current value and the portfolio are the same. Considering the following example:

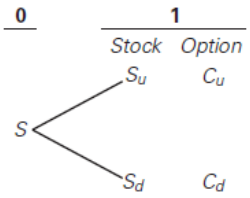

*Figure 31 – Replicating Portfolio approach – **Source: Berk & DeMarzo**, Corporate Finance*

The current value for the stock is S, and it's 1 for the bond (in the next period $1 \times (1 + r_f)$). Consider that, in the next period, the stock price can be worth S_u (upper state) or S_d (lower state), and the value of the option can be C_u or C_d.

To determine the option's value, firstly, we need to know the exact amount of bonds and stocks to be purchased. To do so, it must be ensured that in every state (up and down) the value of the portfolio perfectly matches the value of the option. A system of two equations deriving from the two states must be solved:

$$S_u \times S + (1 + rf) \times B = C_u$$

$$S_d \times S + (1 + rf) \times B = C_d$$

Where S is the number of shares purchased, and B is the bond investment.

By solving the two equations, the results obtained are:

$$S = \frac{C_u - C_d}{S_u - S_d}$$

$$B = \frac{C_d - S_d \times S}{1 + r_f}$$

Remembering that the shares of the project is not something that you can find on the market, so firstly the value of the project without flexibility has to be found (discounted at the risk of the project).

Since the unknown parameters S and B have been determined, it can be calculated now the value of the call option today by substituting the parameters previously calculated:

$$C = S \times S0 + B$$

The method can be extended to multi-periodal and multi-states problems and can be solved by backward integrating. When the number of periods is assumed to be infinite, the Black-Scholes method can be applied.

4.2.4.1.2. Black Scholes method

As said before, the Black-Scholes can be seen as an extension of the binomial pricing model. This method retains a common feature with the previous model: the unknown probabilities of the different states assumed by the share price in the next period. Assuming the stock pays no dividend, to apply the formula, the following parameters must be known:

	Financial Options	Real Options
S	Current stock price	Underlying project
T	Number of years before expiration	Decision date
K	Exercise price	FCF related to the exercise of the option
σ	Volatility (annual) of stock	Volatility of the project
r_f	Risk-free rate	Risk-free rate

*Table 24 – Black-Scholes parameters – **Source: Berk & DeMarzo**, Corporate Finance*

The value of the call option can be determined with the following formula:

$$C = S \times N(d_1) - PV(K) \times N(d_2)$$

Where P.V. (K) is the P.V. of the r_f zero-coupon bond. N(d) is the cumulative normal distribution. The two numbers d_1 and d_2 can be identified as follows:

$$d_1 = \frac{ln\frac{S}{PV(K)}}{\sigma\sqrt{T}} + \frac{\sigma\sqrt{T}}{2}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

The difficulty of this model resides in the computation of the volatility. It can be calculated in two ways. The first one is to collect a sample of stock returns of past months and to observe the volatility day by day. Another approach can be constructed from direct observation of traded options' volatility by monitoring the current stock market prices. This volatility is knowns as *implicit volatility*.

The formula can be rewritten, considering that the stock pays dividend:

$$S^x = S - PV(Div)$$

Dividends are paid before the option's expiration date. Generally, the stock price, as stated in the previous chapter, at the dividend payment date, can decrease by the same amount.

A consideration to be made is that the first two methods considered provide the same pricing irrespectively from the risk preferences of investors; in fact, no assumptions about the risk has to be made. This consideration does not hold for the next method.

4.2.4.1.3. Risk neutral probabilities method

The significant difference between this method and the previous two methods is that, in this approach, the probabilities of the two states are known. The idea behind this method is that the value of the option is calculated discounting the payoff at the cost of capital. The cost of capital is the risk-free rate if all the investors are risk-neutral.

The risk-neutral probability can be calculated in the following way (the risk-free rate must equal the expected return of the stock):

$$r_f = \frac{\rho S_u + (1-\rho)S_d}{S} - 1$$

So that:

$$\rho = \frac{(1+r_f)S - S_d}{S_u - S_d}$$

Once the risk-neutral probability has been calculated, the value of the option can be determined by discounting the expected payoff:

$$P_0 = \frac{\rho C_u + (1-\rho)C_d}{(1+r_f)}$$

To conclude, real options are a very complicated method; for this reason, they are generally used to support the DCF calculation. The value obtained through real options and DCF can be very different; in fact, especially in the early stages, the discount rate can be high, leading to a low value of DFC, while for real options, the opposite statement is true. In fact, the higher the risk and the uncertainty, the higher the value. Despite ROV's (Real Option Valuation) high degree of complexity, they can be employed when the NPV calculation returns a negative value, but there are other reasons for which a company may want to proceed in that direction.

4.2.5. Valuation of intangible assets

(Re-Jin, Lev, & Zhou, 2005) Usually, the main asset of biotech companies is the intangible one. For this reason, it is essential to focus on the valuation of intangibles. Intangible assets are also the most difficult to value. Thus, a valuation method for the biotech industry can be determined with the non-financial fundamentals. The intangibles can be:

- Patents owned;
- R&D expense;
- Alliances and joint ventures;
- Number of products in development;
- Investment in organizational capital (such as management improvement or training of employees);

A method to calculate the value of intangible assets is called calculated intangible value (CIV). Intangible assets can be very difficult to calculate for two reasons:

- They aren't physical assets;
- It is not easy to convert an intangible asset into cash.

Traditionally, the way for calculating the value of intangible assets has been as a subtraction of the market value from the book value. A problem with it arises, because their market value changes too often thus leading to the necessity of making changes to the calculations often. The difference from the traditional method to the CIV is that the CIV is fixed and does not change following the market value. To be able to calculate it, some inputs from the financial wealth of the firm are required as the pre-tax earnings, the tax rate, the return on assets etc.

The process is described in the next table:

1	Calculation of the pre-tax earnings (average) taking into account the last 3 years
2	Calculation of the tangible assets value (average) taking into account the last 3 years
3	Calculation of the ROA of the firm
4	Calculation of the ROA (average) of the industry taking into account the last 3 years
5	Calculation of the excess ROA multiplying the average industry ROA times the average tangible assets; Then the excess ROA will be subtracted from the average pre-tax earning
6	Calculation of the tax rate (average) taking into account the last 3 years; multiplying the average tax rate times the excess return; then subtract the result from the excess return
7	The last step is the calculation of the NPV of the after-tax excess return

Table 25 – Intangible Asset value

In the past, literature was focusing its attention on traditional valuation methods; recently, it has been proven an approach for valuation based on the value of intangibles, given that, the Biotech industry is a sector with few financial information available of companies and many companies without revenue.

(Morales & Radoniqi, 2018) proved the theory empirically by building an econometric model to see each intangible asset's influence on the value of the Biotech company.

Firstly, the authors focused the attention on what the intangible assets may be and how they can be measured empirically. The measures used are expressed as follows:

R&D can be measured by:

1. *Number of patents owned*: it is aimed at understanding the output knowledge of the firm; it only measures the degree of knowledge at the end of the discovery period;
2. *Products in the Biotech company's clinical pipeline*: It aims to investigate the products that can be marketable or, rather, the products in the development stage; it is a useful measure given that many inventions that have been patented may not even enter the development phase. For this reason, this measure is complementary to the previous (number of patents).

In the econometric model, the two measures of the R&D are expressed as $\frac{PAT}{R\&D}$ that is the percentage of patents over the R&D expense and as $\frac{CLIN.TRIAL}{R\&D}$ that is the percentage of

clinical trials over the R&D expense. Moreover, the quality of the portfolio of assets owned by the company is measured by the number of citations received for the patents, $\frac{CITES}{PAT}$.

Other intangible assets are identified in alliances and acquisitions. The main difference between the two activities is that the first one entails a higher degree of flexibility, allowing for scale up and down quickly, while the second allows only a faster scale-up; the reduction of productivity can be more challenging to be achieved. They are measured in the model as a percentage of alliances and mergers over the total assets: $\frac{R\&D}{A}$, $\frac{ALLIANCES}{A}$, $\frac{M\&A}{A}$.

The organizational capital includes all the activities done to increase the efficiency that can be identified in the change of the management system or in more efficient training programs for the employees; it is measured by: $\frac{ORG.CAP}{A}$. Moreover, the organizational capital is measured by the SG&A expenses of the company.

4.2.5.1. Value of the firm

(Morales & Radoniqi, 2018) The value of the biotech firm is identified thanks to the Tobin Q formula. The formula expresses the influence of the intangible measures on the performance of the firm. Of course, the formula has been modified in order to account for the diversity that characterizes the biotech sector. The firm can be seen as a set of intangible and tangible assets.

$$V_{it} = q_{it} f(X_{i1t}, X_{i2t}, X_{i3t}, \dots, X_{int})$$

Where V is the value of the firm i at time t, q is the coefficient representing the market value of the company and X represents intangible and tangible assets i at time t. Moreover, q can be seen as the exponential of respectively, the effect that is firm-specific, the time effect and an error term):

$$q_{it} = exp(b_i, c_t, u_{it})$$

The firm's value that is the dependent variable of the model can be represented by the weight of tangible (identified by A) and intangible assets (identified by K), as said before, that are assumed to be separable entities. In the following formula, the price of intangibles is determined by β.

$$V_{it} = q_{it}[A_{it} + (\beta)K_{it}]^{\sigma}$$

Given that the formula entails a production function, σ represents the return to scale that expresses the L.T. relation about the output and the inputs. In other words, what happens

to the output if the input rate increases or decreases. In this context, the output is assumed to increase proportionally as the inputs, thus, σ is equal to 1.

Rearranging the formula, by the tangible assets, it can be obtained:

$$\frac{V_{it}}{A_{it}} = \frac{q_{it}}{A_{it}}[A_{it} + (\beta)K_{it}]$$

$$\frac{V_{it}}{A_{it}} = q_{it}[1 + \beta(\frac{K_{it}}{A_{it}})]$$

Adding all the previously made considerations and identifying the ratio $\frac{V_{it}}{A_{it}}$ as the Tobin Q, the formula becomes, switching to logarithms:

$$logQ_{it} = log\ \frac{V_{it}}{A_{it}} = b_i + c_t + u_{it} + \log\,[1 + \beta\,(\frac{K_{it}}{A_{it}})]$$

In addition, another important consideration has to be made which is, intangible assets can be used to signal success to investors. In fact, R&D expenditure signals the company's attention to some projects; the number of patents indicates to investors the degree of knowledge possessed by the company; the number of products in the pipeline expresses the company's potential future success; M&A communicates an increase in company capabilities and the creation of synergies, which can thus increase the company value; and the organizational capital signals to investors a possible increase in efficiency, which thus increases the corporate value.

The results that the authors obtained from the econometric model follows:

	(1)	(2)	(3)
R&D / Assets			
	0.264***	0.155***	0.190***
	(0.064)	(0.052)	(0.071)
Patents / R&D			
	0.301*	0.250*	0.304**
	(0.155)	(0.142)	(0.148)
Citations / Patents			
	0.005**	0.004**	0.004*
	(0.002)	(0.002)	(0.002)
Org. capital / Assets			
		1.079***	1.494***
		(0.249)	(0.343)
Tech. alliances / Assets			
		0.714**	0.557*
		(0.302)	(0.296)
M&A / Assets			
		-0.274	-0.164
		(0.754)	(1.083)
(R&D / Assets) * Age			
	-0.002**	-0.002**	-0.005***
	(0.001)	(0.001)	(0.002)
Employees			
	-0.150*	-0.131*	-0.502***
	(0.079)	(0.077)	(0.176)
Firm age			
	-0.012	-0.007	-0.013
	(0.011)	(0.011)	(0.019)
D (Patents=0)			
	-0.138	0.012	-0.043
	(0.086)	(0.084)	(0.093)
N	2,182	2,182	1,220
R^2	0.241	0.300	0.375

*Figure 32 – Regression with the firm's value as a response variable – **Source**:* Intangibles and the Market Value of Biopharmaceutical Startups, *Morales & Radoniqi*

Four models have been built in order to study each effect of the category of intangible assets over the Q ratio.

- Model 1 focuses on the influence of R&D, patent citations, and number of patents;
- Model 2 adds the effect of M&A, alliances, and organizational capital;
- Model 3 takes into account firms after only six years from the going public process and tries to understand the importance of intangible assets for young biotech firms;

It is crucial to study model one and model two separately to understand whether the model's predictive variables alone explain enough variability of the response variable. Model two is useful for understanding whether there is a sharp increase in explained variability or not. If there is an increase, then it means that the intangible assets referring to the number of patents owned and R&D expenditure are not enough to explain the value of a company, but also alliances and acquisitions must be considered relevant.

The asterisks represent the level of significance of the tests completed. Where:

- *** 1 percent significance level;
- ** 5 percent significance level;
- * 10 percent significance level;

It can be seen that R&D, patents, and citations are all significant; in fact, R&D is significant at 1% level, citations at 5%, and patents at 10%. Moreover, the three effects are positively affecting the value of a biotech firm.

It can be observed, that the model explains only 24% of the variance of Q ratio.

The second model adds other regressors, previously described, and the consequence is an increase in the amount of variance explained. Unfortunately, the authors plotted only the R^2, which can be misleading, piloting to wrong results as it always increases, increasing the number of regressors. A more precise measure, adding predictors in the model, could have been identified in the adjusted-R^2.

By adding three new regressors, it is visible that the other coefficients change. It can be noticed that organizational capital and alliances are positively affecting the firm's value; moreover, they are significant. In contrast, M&A seems not to be significant at all.

Model three, instead, investigates the relation between the intangible assets and the value of young biotech firms. It can be noticed that the coefficients are relatively stable; they only slightly changed. Moreover, the variance explained by this model increased to 37,5%. It can be compared to the variance explained in model two of 30% because in these two models, the number of regressors used to describe the response variable is the same. In conclusion, the presence of intangible assets is even more important for younger firms than well-established ones.

I have reported this study to show an empirical evidence that intangible assets are important for corporate valuation purposes. This is an important finding, especially for chapter five (empirical analysis of the biotech IPOs).

4.3. Conclusions

4.3.1. Comparisons between the methods

To conclude, a firm's valuation is a critical step for a company wishing to be bought in the near future or wishing to receive public funding. Valuation is not an exact science;

there are plenty of methods in the literature. Moreover, a mix of them can be used to allow the valuation to be more precise.

Reviewing the most important characteristics and distinctions of the different valuation methods for biotechnology is essential.

First of all, in the previous chapter, we said that the DCF calculation also entails the estimate of a terminal value. As said before, for biotechnology, the terminal value is generally close to zero because when the patent expires, the revenue for the drug collapses.

Moreover, it has been said that, for biotech companies, a rNPV is more suitable than merely the NPV approach due to the increase in the precision in accounting the success of completion of the phases of drug development. The rNPV uses the same methodology of the DCF, but what changes is the discount rate used. It perfectly fits the Biotech sector because the development process is highly standardized, and the success rates can be discovered by historical data.

The venture capital method is the valuation from the perspective of an investor. In fact, it evaluates the time requested by the investment and the risk. To achieve the goal, it uses higher discounts for the early stages. It is often used for the biotech industry in which companies have no earnings, and it is essentially easier to evaluate the potential exit.

For what regards the comparable methods, it can be difficult to apply either the market comparable (most of the public companies show no earnings for many years) and the past transactions approach due to the high specificity of the companies making the comparison difficult. Given that there are few information about financial data, and few earnings for biotech companies, other multiples can be used, different from the ones analyzed in the previous chapter; They can be based on the number of employees, on R&D expense and also on the money raised.

The real options approach is the most accurate one; it is deployed when the NPV would return a negative value, but the management wishes to proceed in developing the project. The main difference between the ROV and the NPV is that the first one considers the flexibility while the second does not.

Last but not least, it can be imperative to assess the value of intangible assets; for a biotech firm, intangible assets might be more significant than tangible ones and are the main value driver for a company (empirically showed).

4.3.2. Risk and rewards

Given that the value of a company depends on future risk and rewards, the following table will try to evaluate all the possible types of discount rates deployed and the methods to take into account the rewards. Once more, it is important to say that there is not the right valuation method; the valuation depends on the assumptions (about risks and rewards) that investment bankers or investors make to assess it. Potential risks can be groups into three macro classes, as follows:

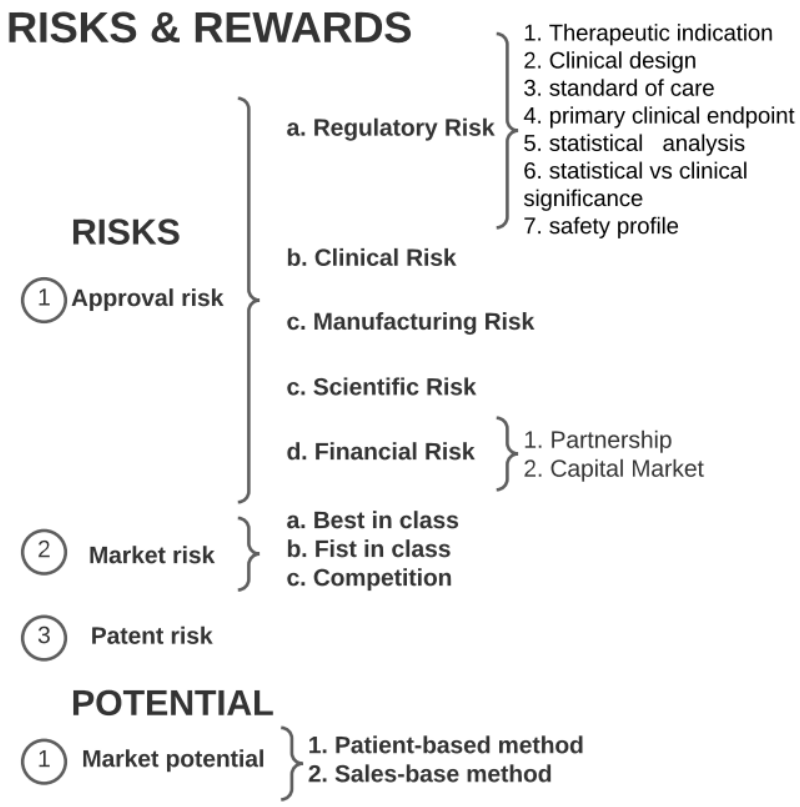

Figure 33 – Risks and Rewards in the Biotech sector

The first category of risk is identified in the approval risk, the risk that can be incurred in the process leading to the drug's approval. This risk can be divided into categories that can be seen in the figure. The regulatory risk is related to all the regulations that are required by the FDA for a drug to be approved. A company developing a drug must take into account all the regulations during the whole process of development. Instead, the financial risk is related to the method in which funding is received; the main strategies, as said before, are constituting a partnership with another firm, generally a Big Pharma company or getting listed. Moreover, also the manufacturing risk belongs to the category. It includes the risk related to the GMP (*Good Manufacturing Practices*). GMP constitutes a series of rules aimed at the guarantee of appropriate quality standards. Furthermore, every

step of the manufacturing process must be documented in the GMP. The scientific risk is related to the drug's potential as a target for a particular disease and how this drug works.

Market risk can, in turn, be divided into three categories, which differ according to the level of competition. A first-in-class drug will generally succeed in supplanting the competition of similar drugs for the same disease. In the competition between similar products, even a drug that is best-in-class will generally survive the. The same drug competes not only with similar products that have already been approved by the FDA but also with similar products that are in the same stage of development and even with products that are also in development stages prior to its own but which have the potential to successfully conclude the stages. The degree of competition requires a careful analysis and can start searching on the FDA's website, for drugs already been approved and on the clinical trials of government website for medicines that are candidates to cure the targeted disease.

Another risk to be considered is the patent risk. In fact, a biotech company must be sure that its medical products do not infringe any other patents. The risk can be identified in the pending period in which patents are not available yet to be consulted.

In addition, the market potential can be estimated through two approaches that are the *patient-based method* and the *sales-based method*. The first method is based on an estimate of the number of patients suffering from that particular condition; However, patients who are already being treated with a drug targeted for the condition should also be counted. The second method instead tries to estimate the drug's sales and, in this case, we must consider the drugs already existing for the disease. The research aimed to find how the disease's incidence, thus, the number of potential patients can start from the website of *Nice National Institute For Health and Clinical Excellence*. It is an international importance institute that analyzes the biotechnology field's literature, evaluates the cost/effectiveness ratio, and produces guidelines on therapeutic procedures and the efficacy found.

In other words, risk and rewards must be considered in the valuation process and must be balanced. Companies are suggested to do a risk and reward analysis periodically.

CHAPTER 5- ANALYSIS

5. Analysis

5.1. Underpricing in the Biotech industry

This chapter analyzes the phenomenon of underpricing in the IPO process of companies belonging to the biotechnology sector.

I created the sample based on SIC CODES that belong to this sector.

The sic codes are four-digit numbers deployed to identify the industry to which the company belongs. SIC derives from Standard Industrial Classification.

The following codes are examples of SIC Codes that fall within the biotechnology field:

- 2834 Pharmaceutical preparations;
- 2835 In Vitro & In Vivo Diagnostic Substances;
- 2836 biological products;
- 8733 Noncommercial Research Organizations;
- 3741 Pharmaceutical and medicine industry;
- 3841 Surgical & Medical Instruments;
- 3845 Electromedical & Electrotherapeutic Apparatus;
- 8731 Services-Commercial Physical & Biological Research;
- 8689 Health Laboratories;
- 8071 Services-Medical Laboratories;
- 5122 Wholesale-Drugs;
- 3826 Laboratory Analytical Instruments.

5.1. Description of the dataset & descriptive analysis

The first part of the study is based on a descriptive analysis of the sample. The descriptive analysis shows the most relevant statistics for each variable and, graphically, the possible association of the response variable (underpricing) with potential predictors. In contrast, the second part is devoted to identify the possible explanations of underpricing in the Biotechnology sector using SAS software. The research focuses on selecting 74 biotech companies that have undertaken an IPO process between 2017 and 2020. The majority of the companies (65%) analyzed belong to the sic code 2834.

5.2. Underpricing

As stated in the theoretical part of the thesis work, the underpricing is the practice whereby the fixed issue price is lower than the market value of the securities at the time of issuance and is represented by the following formula, that I used in the dataset:

$$Underpricing = \frac{P\ end\ first\ day\ of\ trading - P\ issue}{P\ issue}$$

The following chart analyses the distribution of underpricing grouped by year in which the IPO process took place. As it can be noticed, the underpricing tends to be higher in the year 2020 that is characterized by a high overall level of risk due to the pandemic situation and the intense focus on the Biotechnology sector. The year 2020 is distinguished by a higher level of initial excess return and higher variability.

An essential measure of the investment risk can be identified in the variability. Following this path, the investment risk is lower for firms that undertake the IPO process in the years analyzed before 2020.

Analysis of Underpricing

The MEANS Procedure

Analysis Variable : Underpricing						
Year_of_ipo	N Obs	Mean	Median	Minimum	Maximum	Variance
2017	12	0.13	0.09	-0.18	0.71	0.06
2018	11	0.10	0.00	-0.29	0.63	0.09
2019	30	0.11	0.04	-0.31	0.81	0.08
2020	21	0.54	0.49	-0.04	1.98	0.30

Figure 34 – Statistics for underpricing

Most firms (67%) show underpricing in the sample studied, while only 24% of the model experienced an overpricing.

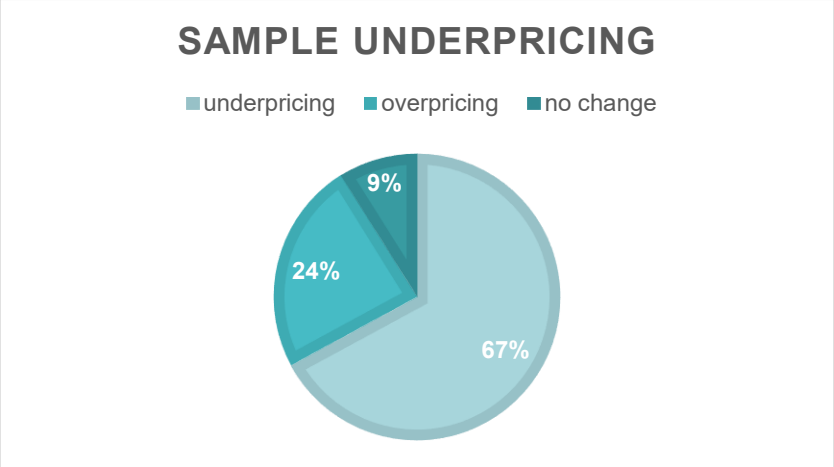

Figure 35 – Sample distribution of underpricing and overpricing

The variables analyzed are the following:

5.2.1. Underwriters characteristics

In the second chapter that analysis the theories in the literature, it has been said that firms undertaking an IPO try to reduce the risk in the investors' eyes by following two strategies:

- The first one is hiring good quality underwriters to decrease the "money left on the table";
- The second one, instead of the quality, focuses on the number of underwriters that are part of the underwriter syndicate. The IPO risk, in this case, is spread across different investment banks. Therefore the higher the number of underwriters, the lower the underpricing level should be.

5.2.2. Underwriters quality

As said in the theoretical chapters, underwriters are usually large banks essential before the IPO takes place, during the IPO process, and after the IPO because they manage the aftermarket risk.

The relation between the underwriters' quality managing the process and the underpricing level has been studied in theory.

It is, therefore, necessary to understand how to evaluate the quality of an underwriter. To this purpose, Carter and Manaster wrote in 1990 *Initial Public Offerings and Underwriter Reputation* (Carter & Manaster, 1990). The authors put forward the hypothesis that low-risk companies choose a highly reputable underwriter to communicate it to the market. A low-risk company is defined as a company having a low dispersion in the value of the firm.

Carter and Manaster relied on the "tombstone announcements" from 1979 to 1983 to rank the underwriters' quality. The "tombstone announcements" herald to investors the future IPOs that the underwriter in question will follow.

The first underwriter listed in the "Tombstone announcement" is the lead underwriter. The co-lead underwriters, if they exist, follow it.

Therefore, Carter and Manaster based their ranking on the underwriters' position in Tombstone announcements. The authors assigned each underwriter a number comprised between 0 and 9.

The following picture represents how they assigned the ranking based on the underwriters' position. The underwriter nominated in section A is the lead underwriter. Below the lead underwriters are listed the syndicate underwriters.

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February 2, 1983

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A		Eppler, Guerin & Turner, Inc.		
B	Bear, Stearns & Co.	Blyth Eastman Paine Webber Incorporated	Lazard Freres & Co.	Prudential- Prudential-Bache Securities
	L. F. Rothschild, Unterberg, Towbin		Wertheim & Co., Inc.	Dean Witter Reynolds Inc.
C	Advest, Inc.	Allen & Company Incorporated	Alex. Brown & Sons	Landenburg, Thalmann & Co., Inc.
	Moseley, Hallgarten, Estabrook & Weeden Inc.		Oppenheimer & Co., Inc.	Rothschild Inc.
D	Thomson McKinnson Securities, Inc.			Arnhold and S. Bleichroeder, Inc.
	Interstate Securities Corporation			Janney Montgomery Scott Inc.
	Johnson, Lane, Space, Smith & Co., Inc.		Legg Mason Wood Walker Incorporated	Neuberger & Berman
	Robinson Humphrey/American Express Inc.			Wheat, First Securities, Inc.
E	Johnston, Lemon & Co. Incorporated			Nippon Kangyo Kakumaru International, Inc.

Figure 36 – Tombstone announcement – Source: Initial Public Offerings and Underwriter Reputation, Carter & Manaster

The ranking of Carter and Manaster was updated by Jay Ritter and Tim Loughran in 2003 (Ritter & Loughran, 2004).

I used Ritter's classification in the dataset to classify the underwriters based on their reputation. The following picture is an example of how I set the ranking:

	A	B	C	D	E	F	G	H	I	J	K	L	M
	YearIPO	Company_name	sic	Underwriters_names	quality_LeadU	quality_u2	quality_u3	quality_u4	quality_u5	quality_u6	max quality	Sum_underwriters_ranking	NumUnderwriters
	2017	Biohaven Pharmace	2834	Morgan Stanley/ Piper Jaffray/ Barclays Capital	9	7	8				9	24	3
	2017	BeyondSpring Phan	2834	Rodman & Renshaw (a Unit of H.C. Wainwright &	5						5	5	1
	2017	Akcea Therapeutics	8733	Cowen and Company/ Stifel/ Wells Fargo Securi	6	7	8				8	21	3

Figure 37 – Underwriters data in the dataset

Moreover, I have also adopted another way of classifying the underwriters' reputation that is more recent. This new method is uploaded as an article to Ritter's website, and it is called *"List of underwriters of European IPOs (update 2017)"* (Migliorati & Vismara, 2014).

In the previously cited article, the reputation of underwriters has been calculated in absolute terms and relative terms. I decided to use the relative one, given the high variability in the underwriters' size. For this reason, in my dataset, I reported the underwriters' quality proceeds-weighted (called *eu_quality*).

G	H	
eu_quality	flag_quality(>0,5)	r
0,9	1	

Figure 38 – quality of underwriters in the dataset

From a graphical perspective, it can be observed that Biotech underpricing seems to slightly decrease following an increase in the quality of the underwriters, as stated in theory.

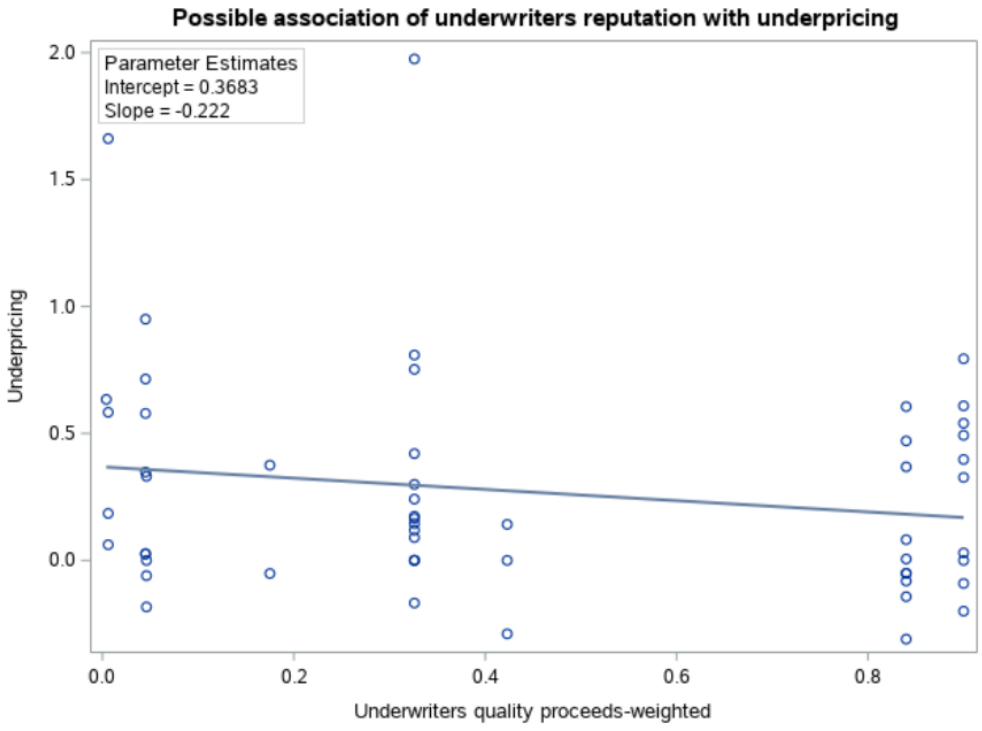


Figure 39 – Scatter plot representing the association between underpricing and underwriters quality

To better visualize the difference in the underpricing levels across investment firms' quality, I inserted in the study a dummy variable equal to one if the underwriter's quality is greater than the average value and 0 otherwise (called *flag_quality*). It can be seen in the box plot that for low-quality underwriters (coded with 0), the initial return seems higher.

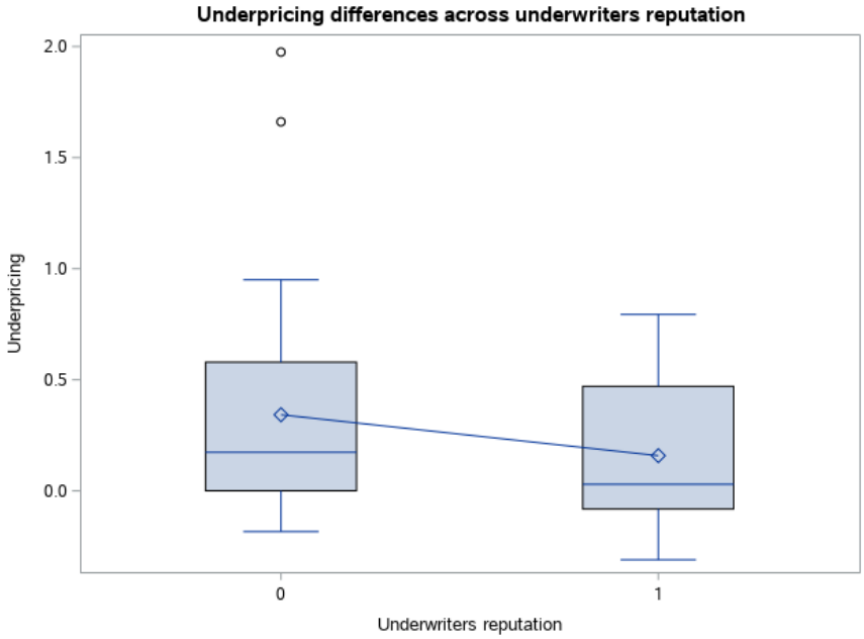


Figure 40 – Box plot representing how underpricing levels change with respect to the underwriters quality

5.2.3. Number of underwriters

For each firm in the dataset, I reported the lead underwriter and the underwriters constituting the syndicate. For each underwriter, a column identifying its reputation according to Carter and Manaster has been highlighted. Another column determines the number of underwriters undertaking each IPO.

Corwin and Schultz in 2005 discovered that in traditional IPOs low underpricing is associated with a higher number of underwriters constituting the syndicate (Corwin & Schultz, 2005) due to:

- an increase in the analyst coverage;
- A more precise price-setting because of the experience of many investment banks.

However, this statement in the Biotech industry seems not true following a graphical analysis of the dataset.

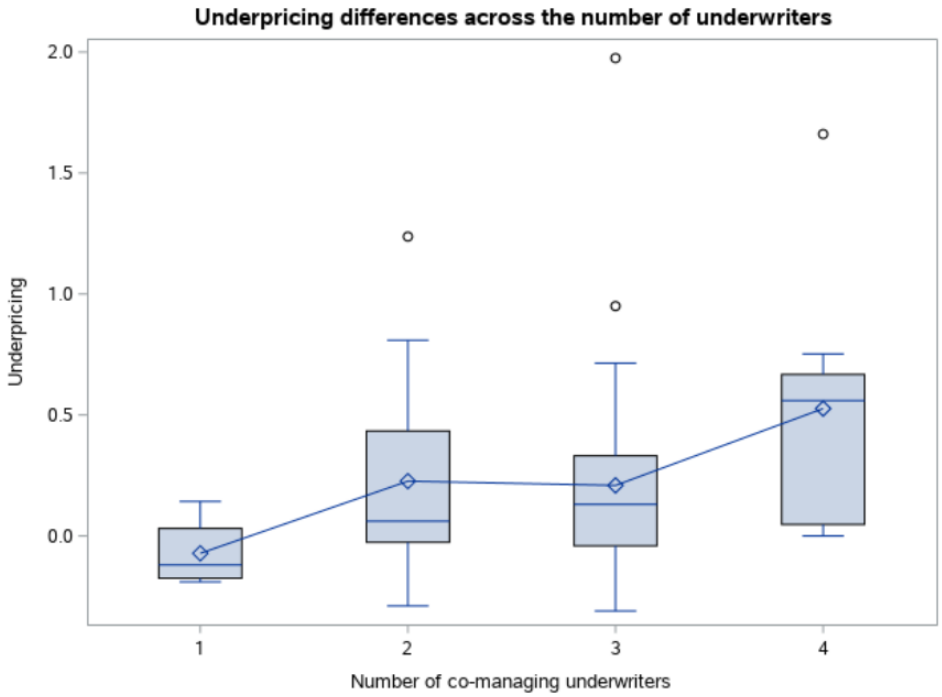


Figure 41 - Box plot representing how underpricing levels change with respect to the number of underwriters

It seems that the higher the number of co-managing underwriters, the higher the initial returns. More in-depth, the level of underpricing seems not affected by two or three underwriters, given that a horizontal line connected the means of the two boxes. Instead, if the number of underwriters is four, or if there is only an underwriter undertaking the process, the underpricing seems affected.

5.2.4. Venture Capital

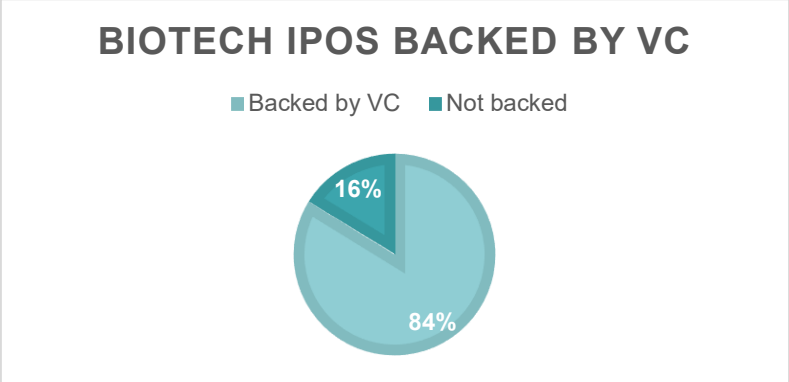


Figure 42 – Sample distribution of VC-backed IPOs

The dataset highlights that venture capitalists had backed most biotech IPOs from 2017 to 2020. In the subsequent regression analysis, the dummy VC is not be significant probably due to the low number of non-backed IPOs compared to the backed-ones.

The first peculiarity of Biotech is that the IPO backed by VC is not mainly used as an exit but as a huge source of funding to support the very high R&D spending.

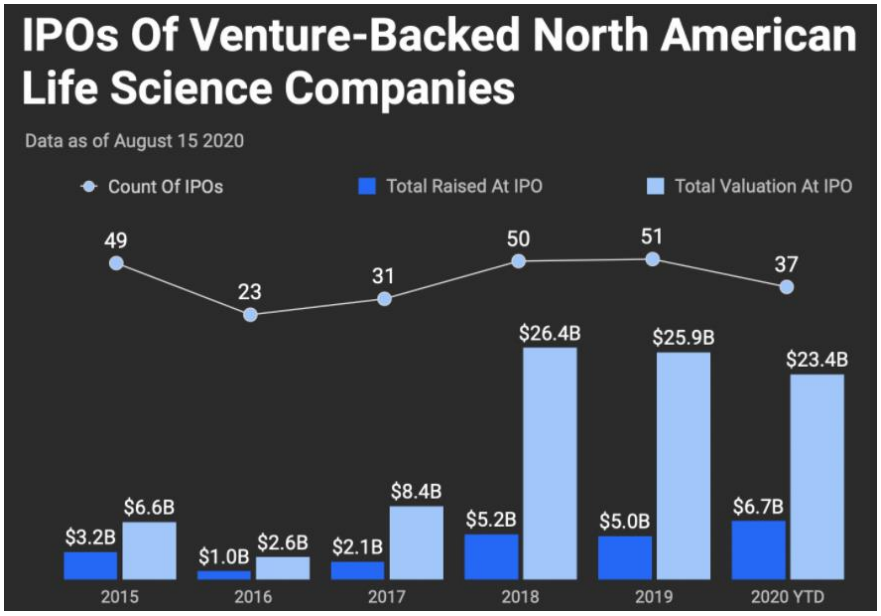


*Figure 43 – Biotech IPOs in North America from 2015 to 2020 – **Source**: Crunchbase news*

In 2020, both biotech IPOs and venture capital financing in the biotech sector increased. One factor that certainly helped to increase the interest of markets in the biotechnological world was the necessary fight against Covid19. The phenomenon suggests that the increase will continue over time and that Covid19 has been just a catalyst for the reaction.

In the following chart, it can be noticed that fifty percent of VC-backed IPOs can be identified in the Biotechnology industry in 2013.

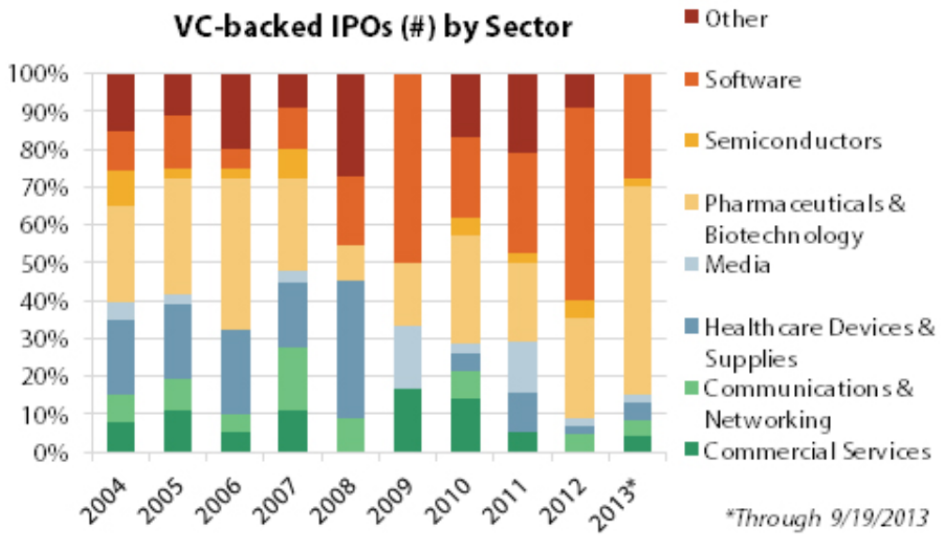


Figure 44 VC-backed IPOs until 2013 – Source: Top 5 VC-backed Biotech IPOs: Who's Leading the Boom?, PitchBook

The increasing trend seems not to change after 2013. In fact, Forbes wrote that Biotech VC-backed IPOs are at a peak during the pandemic situation, with altogether 5,5 billion dollars raised in 171 IPOs.

(Booth, Forbes, 2020) An important consideration made by Forbes is that Biotech financing does not follow the economic cycle. It is common sense to think that stock valuations follow capital markets. In the biotechnology context, the companies' valuation is based on accrued data instead of financial metrics.

This phenomenon explains why biotechnology performs better than other sectors even in times of global recession.

This statement can not be fully confirmed by the biotech IPO sample. In fact, the distribution of betas is reported as follows:

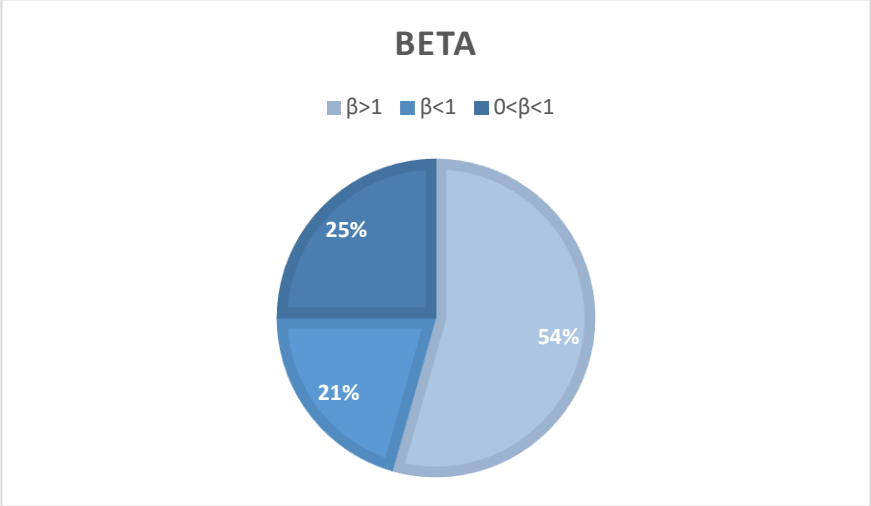


Figure 45 – Sample distribution of beta

Therefore, it is visible that the majority of shares (54%) has a beta that is higher than one. It means that their valuations move in the same direction of the market and that these shares are more responsive than the market, typical of technology shares. The 21% of shares, instead, has a beta which is lower than 1. It is common to think that, in financial markets, gold stocks have a beta lower than 1. These shares perform better when the market goes down. In fact, these shares are characterized by an inverse relation with the market. The remaining 25% is represented by shares having a beta that is lower than 1 but higher than 0. In this case, shares are less volatile than the market.

The next scatter plot shows a positive relation between the underpricing level and the beta. Therefore, the higher the risk, the higher the underpricing.

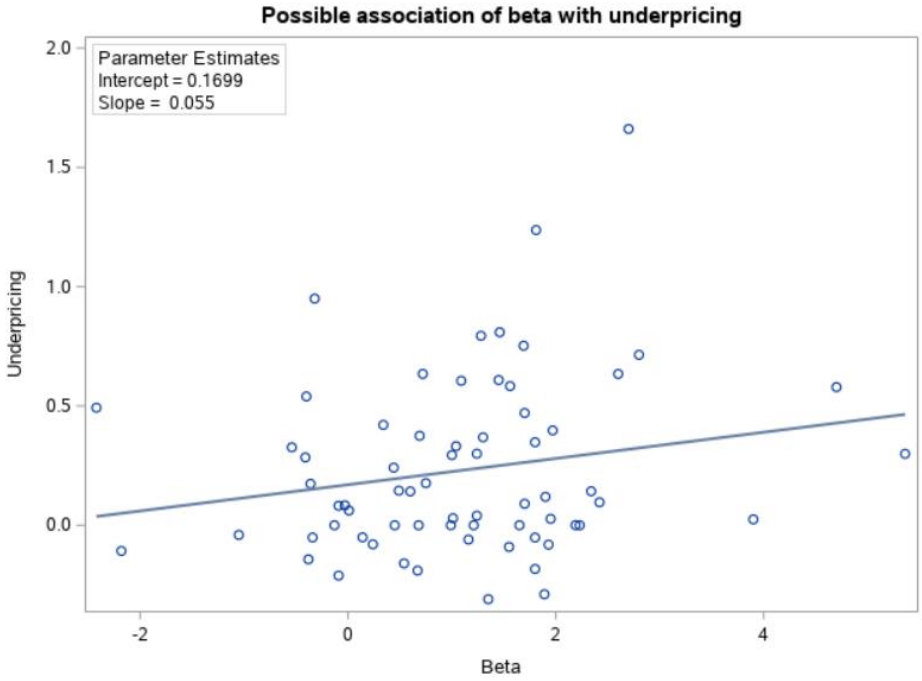


Figure 46 – Scatter plot representing the possible association of underpricing with beta

According to Forbes, the following graph is a deepening of the 2008 recession and shows a severe contraction of investment by venture capitalists across all sectors but constant investment in the biotech field.

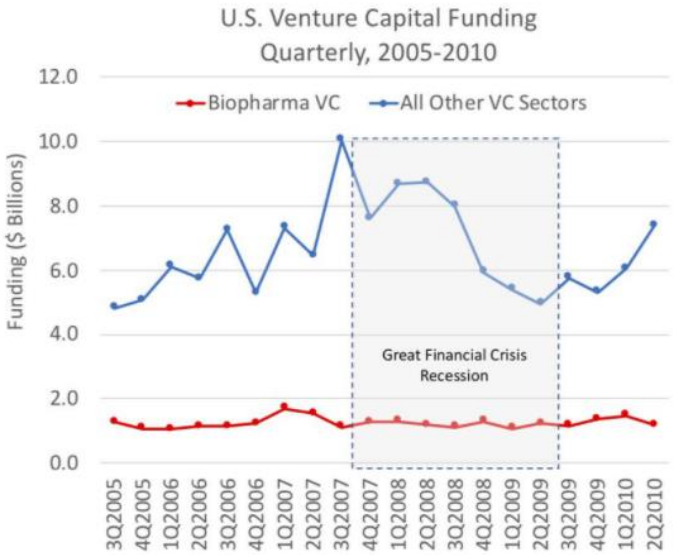


*Figure 47 -VC backing during recessions – **Source**: Booming VC-Backed Biopharma: Strong Market Despite Pandemic, Bruce Booth*

Bruce Booth[19] reported some interesting insights on the topic:

[19] Bruce Booth is a chairman of important biotech firms such as Arkuda Therapeutics and was part of the board of directors of many companies as Magenta Therapeutics.

- During the 2001 recession, while S&P was at -8,9%, NBI was at -0,1%;
- During the 2008 recession, while S&P was at -23%, NBI was at 1%.

Moreover, another critical consideration about why the biotech industry is not affected by financial recessions as the 2020 pandemic situation is that most biotech firms sales are zero; therefore, they are not affected by recessions.

I mentioned earlier that the biotech sector is generally evaluated with data rather than financial measures. (LifeSci VC, 2020) The report written by LifeSci VC called *Strategic Planning In Biotech During A Pandemic Crisis* captures which are the crucial data needed to describe the wellness of a biotech firm:

- Clinical results obtained from Phase 2 and 3;
- safety results obtained from preclinical research and Phase 1;
- R&D expenditure.

I inserted in the dataset a dummy variable, as mentioned above, to take into account which IPO has been backed by venture capitalists. From the boxplot illustrated before, it seems that the underpricing level is affected by the presence of VC.

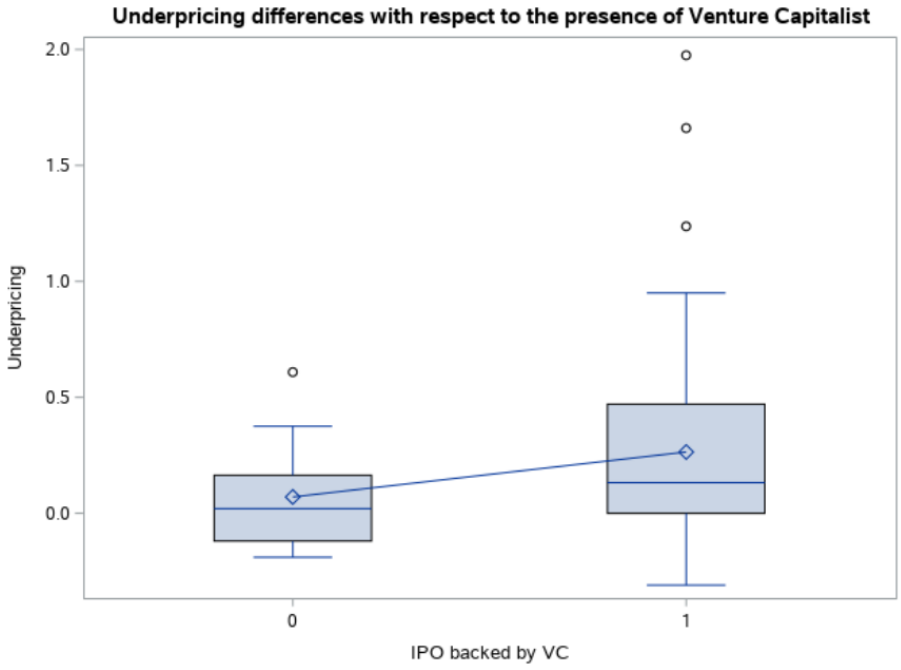


Figure 48 – Box plot representing how underpricing changes with the presence of VC

Against the common thinking, the box plot obtained from the Biotech sample predicts that underpricing seems to increase when the IPO is backed by VCs. The explanation can be found in the theory discussed below, written by Wang & Wan.

(Wang & Wan, 2013) The research named *Explaining the Variance in Underpricing among Venture Capital-Backed IPOs: A Comparison Between Private and Corporate VC Firms* can explain this phenomenon, as states before. It illustrates that private VC-backed IPOs and corporate VC-backed IPOs affect underpricing differently. The fundamental distinction among the two categories is the final aim. Private VCs are mainly focused on a financial result while corporate VCs pursue a strategic purpose. In the study, two relations with underpricing have been discovered:

- Positive relation with private VCs;
- Negative association with corporate VCs.

Private VCs are better at providing firms with early-stage financing, while corporate VCs are more oriented through providing later-stage resources.

Corporate VCs are more oriented to long-term profitability, whereas private VCs are more focused on the short term to get a fast exit. A private VC can push a company to undertake an IPO irrespectively from underpricing, while generally, a corporate VC waits for the best window of opportunity to launch the IPO.

Moreover, private VCs can help the early stage of a company's life by bringing value-added services and personnel that are most needed at the beginning. However, approaching maturity, the firm will not need the VC's competencies anymore, and the VC will not be able to provide the firm the necessary resources. This is why the VC will look for an exit.

On the contrary, the corporate VC will assist the firm also after the IPO is concluded. In this context, in fact, a private VC does not qualify the firm's future prospects as it will happen with a corporate VC. Therefore, higher underpricing levels are associated with the presence of private VCs.

As said before, when the IPO is concluded, usually the collaboration between the firm and the corporate VC continues. For this reason, a theory identifies corporate VCs as firm's insiders. Being an insider means having incentives to decrease underpricing identified in less money to grow the business in the long term.

The presence of corporate VC can be perceived by investors as proof of the good quality of the IPO, leading to a lower expected initial return.

5.2.5. Age

Another interesting characteristic to observe in Biotech IPOs is the age at which the sample's biotech firms decided to go public. The majority of the firms go public during the first years of operations (more than 50% go public before six years). This statement is in contrast with the IPO process of traditional firms.

In fact, Mckinsey reported that in 2014 the average age of traditional firms going public was about 11 years (Begum Erdogan, Rishi Kant, Allen Miller, Kara Sprague, 2016).

This difference can reveal the high need for the capital that biotechnology companies incur during drug development phases.

In addition, in the second chapter of the thesis work called "Understanding the underpricing theories", it has been said that, in traditional firms, a way to quantify the ex-ante uncertainty is to focus on the firm's age and to count the years of business before going public. This statement does not work for the biotech industry.

Statistics for age are shown below.

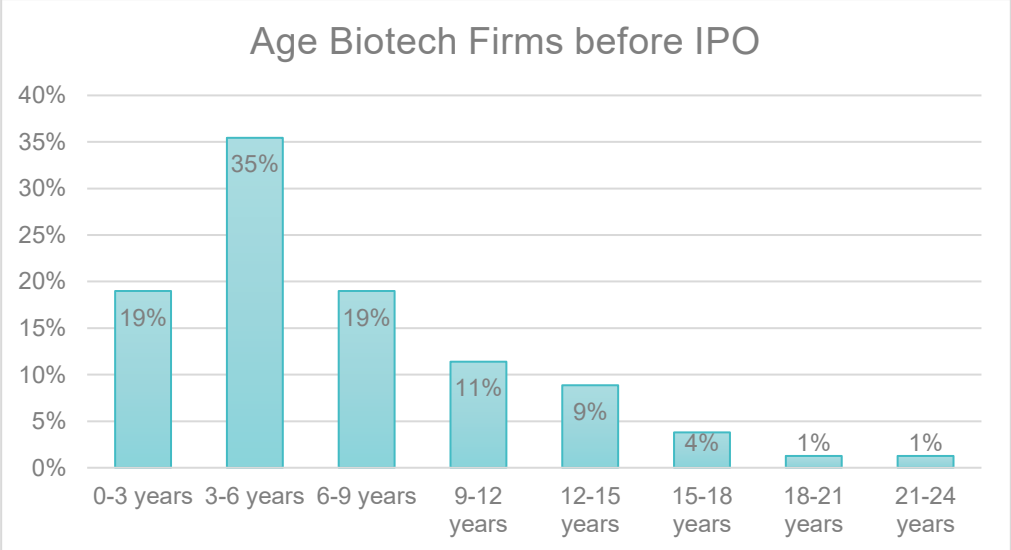


Figure 49 – Sample distribution of Age

Cumulative percentage of the IPO age

The FREQ Procedure

Age				
Age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	4	5.41	4	5.41
2	7	9.46	11	14.86
3	4	5.41	15	20.27
4	12	16.22	27	36.49
5	9	12.16	36	48.65
6	5	6.76	41	55.41
7	4	5.41	45	60.81
8	5	6.76	50	67.57
9	5	6.76	55	74.32
10	4	5.41	59	79.73
11	2	2.70	61	82.43
12	2	2.70	63	85.14
13	4	5.41	67	90.54
14	2	2.70	69	93.24
15	1	1.35	70	94.59
16	1	1.35	71	95.95
17	2	2.70	73	98.65
21	1	1.35	74	100.00

Figure 50 – Frequency plot of age

5.2.6. Offer price

The statistics for the offer price in the sample is shown below.

Statistics for offer price

The MEANS Procedure

Analysis Variable : Poffer Offer price					
Mean	Median	Maximum	Minimum	Std Dev	Variance
15.18	16.00	23.00	4.00	4.00	16.02

Figure 51 – Statistics for offer price

The average offer price of the sample in 2020 is higher compared to the previous years.

Statistics for offer price grouped by year of IPO

The MEANS Procedure

Analysis Variable : Poffer Offer price						
Year_of_ipo	Mean	Median	Maximum	Minimum	Std Dev	Variance
2017	13.00	14.50	20.00	5.00	4.63	21.45
2018	14.64	15.00	19.00	5.00	3.78	14.25
2019	14.23	15.00	20.00	4.00	3.86	14.87
2020	18.07	18.00	23.00	14.00	2.20	4.86

Figure 52 - Statistics for offer price grouped by year

A significant observation on IPO prices has to be made. (Booth, Evolution Of The Biotech IPO Markets From Busted To Booming, 2020) Forbes writes in the article called *Evolution Of The Biotech IPO Markets From Busted To Booming* that the Jobs act (2012) was very important, especially in the biotech sector as two elements lower the risk linked to the sector. One of these two elements can be identified in the greater precision in defining the offer price, thus limiting a price increase following the IPO in the aftermarket.

This greater precision was made possible by the possibility of securing the form s1 (*confidential filing*). Before the JOBS act, this document was public from the time of compilation. Thanks to confidential filing, biotech companies can initiate the IPO process after the offer price range is correct and the market perceives the company as potentially robust.

The second element can be identified in the "Testing the waters TTW". In fact, before the JOBS act, when biotech companies filled out the S1 form they could not keep meeting investors and refine the price range. The only chance they had was to meet investors during the Roadshow. With the advent of the JOBS act, on the other hand, companies were allowed to keep seeing investors. This allows companies to public list with a much more precise offer price.

Moreover, regarding the offering price, another feature needs to be described: crossover rounds. The crossover round is a private financing step before the IPO, carried out by venture capitalists.

The crossover round is not only important in refining the offer price but also in establishing more consolidated relationships between investors and companies. Investors, in fact, enjoy more time to evaluate the company that will carry out the IPO process.

The following scatter plot extrapolated from the sample shows a linear relation between underpricing and offering price.

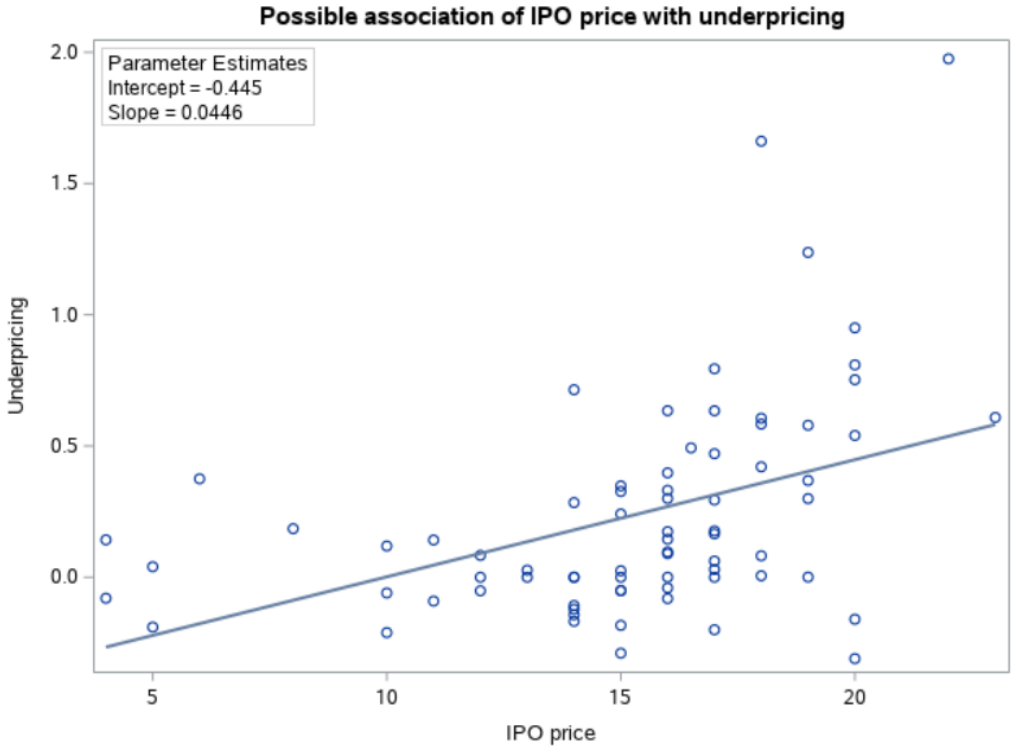


Figure 53 – Scatter plot representing the association of underpricing with IPO price

5.2.7. Number of patents

The theoretical part of the thesis work has stressed the point of intellectual property of biotech companies. More in-depth, it has been said that the most significant part of the value of a biotech company derives from its intangible assets. Therefore, it is substantial to focus intensely on the number and kind of patents owned by the firms. This consideration is important in explaining the underpricing level.

In fact, in the forth chapter of the thesis work called "Biotech valuation" it has been pointed out that the risk in the eyes of investors can be reduced if the company can count on several patents, mainly for two reasons, listed below:

- first, if the drug fails to gain approval, the company will still have the patents and might retry the creation of other medicines as long as they fall within the patent scope.
- second, patents can be highly effective in blocking competitors trying to create the same drug.

The following chart shows the number of patents owned by the biotech firms in the year in which the IPO took place. The results have been searched on the WIPO (*World Intellectual Property Organization*) website, looking for the company's name and restricting the extrapolation only to the patents filed before or at the year of IPO.

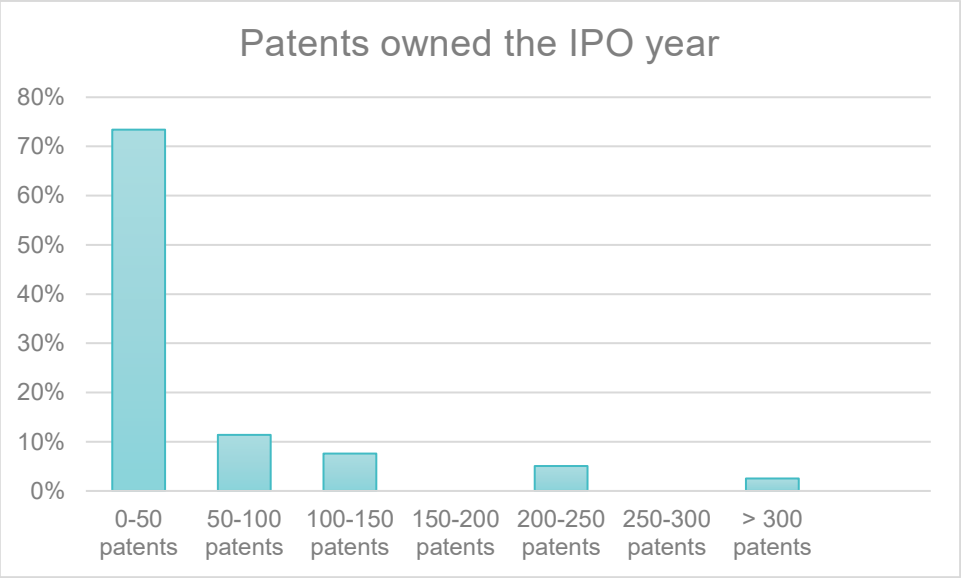


Figure 54 – Sample distribution of patents at the IPO year

Instead, the next chart reports the distribution of patents owned by the same firms now (2020).

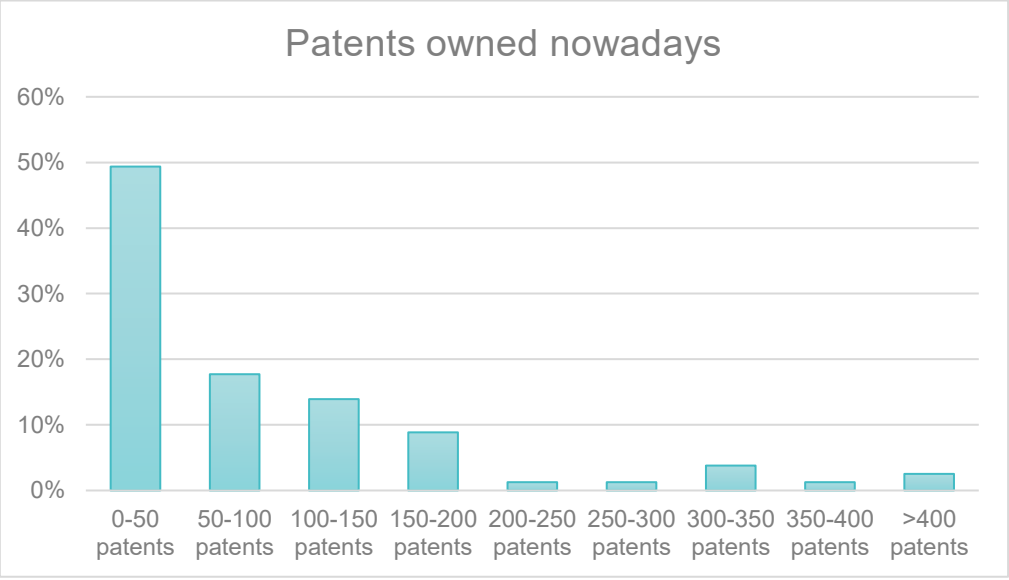


Figure 55 – Sample distribution of patents now

It can be seen that most of the Biotech companies that have undertaken an IPO from 2017 onwards have increased the number of patents by ten units from the year of the IPO to today.

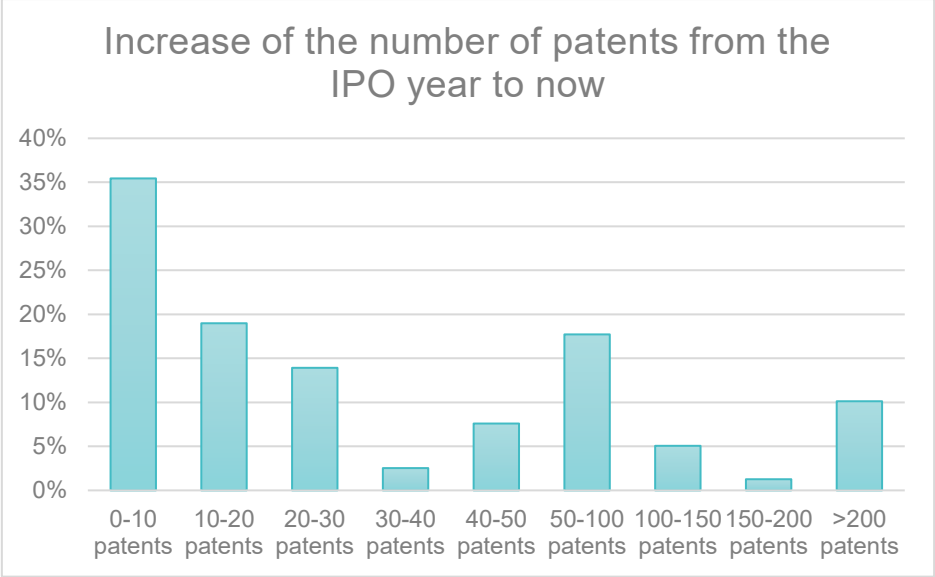


Figure 56 – Sample increase of patents

Patents can give an important insight into the intrinsic risk of a firm going public. To capture it, I calculated a column for every year, from the foundation year to the IPO year, concerning the number of patents developed by the firm that particular year, as shown below.

Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
Npatents_year1	Npatents_year2	Npatents_year3	Npatents_year4	Npatents_year5	Npatents_year6	Npatents_year7	Npatents_year8	Npatents_year9	Npatents_year10	Npatents_year11	Npatents_year12	Npatents_year13	Npatents_year14	Npatents_year15
0	0	2	10	18										
0	0	3	19	24										
0	0	0	0	1	0	4	4	0	2	1	4	5	5	13
0	6	9	34											
0	0	0	0	3	2	3	2	9	15	26	44	54	75	44
0	0	0	0	3	12	17	15	18	14					
1	0	0	1	0	11	17	23	29	14					
0	2	2	6	16	7									

Figure 57 – number of patents of every firm from the year of foundation to the IPO year

The data on the number of patents have been extrapolated by the WIPO website, searching for the company name and filtering by the year requested.

At this point, having collected the number of patents developed by each firm in every year, I calculated three columns as follows:

- Average time (expressed in years) in which a firm develops its patents;
- Number of patents the company developed after the average time of development. This number can give us an insight about how many recent patents have been developed by the firm. Therefore, the higher the number of younger patents, the higher the risk around the company, the higher the underpricing should be;
- Percentage of recent patents over the total number of patents developed by the firm from the year of foundation to the IPO year.

AX	AY	AZ
Average Time	NPatentsafterAVG	%patentsafterAVG
4,727272727	23	0,741935484
3,1875	8	0,444444444
4,303030303	46	
12,06593407	29	0,322222222
6,770992366	61	0,465648855

Figure 58 – sample data about: average development time, number of recent patents, percentage of recent patents over the total number of patents developed by the firm from the foundation year to the IPO year

The statistics for the 3 variables identified before, follows:

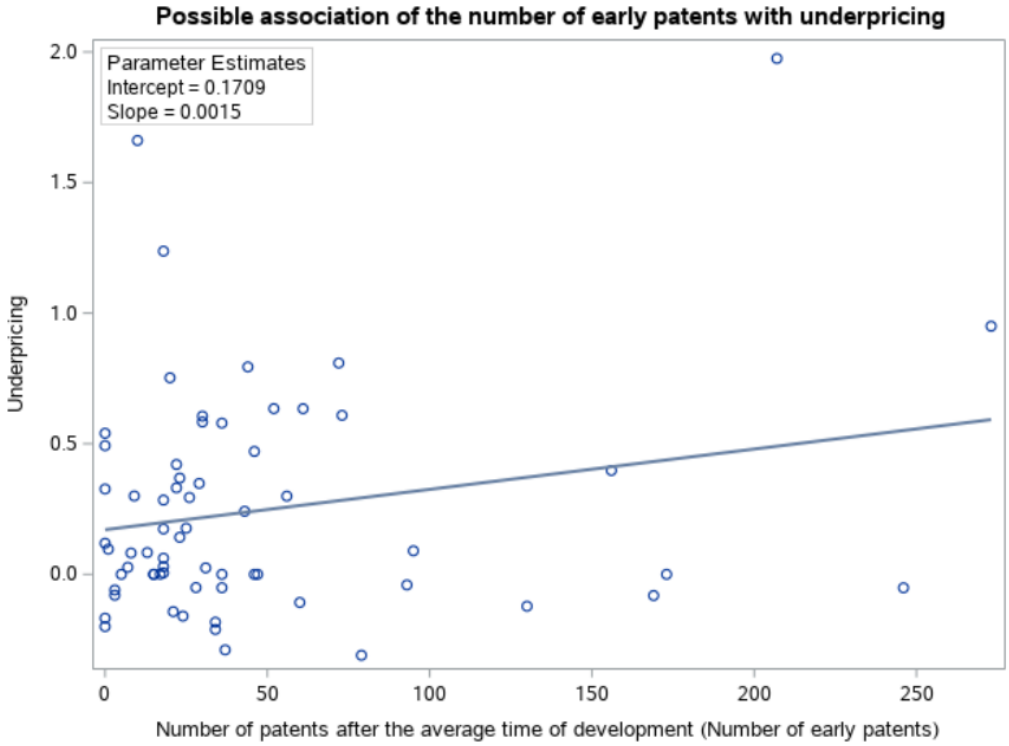
Statistics of early patents

The MEANS Procedure

Label	Mean	Median	Maximum	Minimum
Number of early patents over the total number of patents	0.65	0.59	4.33	0.00
Average time to develop a patent	6.57	6.18	12.71	2.67
Number of patents after the average time of development	46.18	26.00	273.00	0.00

Figure 59 – Statistics for: average development time, number of recent patents, percentage of recent patents over the total number of patents developed by the firm from the foundation year to the IPO year

The positive relation between underpricing and the number of recent patents seems confirmed by the following scatter plot. In fact, the higher the number of recent patents developed the firm owns (risky patents), the higher the underpricing level.



5.2.8. Number of products in the pipeline

As displayed in the thesis work's theoretical part, a vital characteristic to explain underpricing related to Biotech IPOs is identified in the products under development.

Again, as for patents, products in the pipeline can give us essential insight into the intrinsic risk of an IPO.

For this purpose, I searched in the S1 form on the SEC website to estimate the firm-specific risk.

I calculated the number of products in every stage of the development process. I gave a different risk to each stage. I calculated the total risk by multiplying the number of products in each phase for the phase risk, and then I divided the sum by the number of products as shown below.

BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ
TOTproducts	research	preclinical	phase1	phase2	phase3	marketed	TOTALRISK	totalrisk/nproducts	PHASE	RISK degree
18	0	0	5	1	11	1	63	3,5	Research	15
0									PRECLINICAL	10
6	0	0	2	2	1	1	27	4,5	Pahse 1	7
4	0	0	2	0	2	0	18	4,5	Phase 2	5
12	0	3	7	1	1	0	86	7,2	Phase 3	2
7	2	1	3	1	0	0	66	9,4	MARKET	1

Figure 60 – Data about products in the pipeline in the dataset

I calculated the different risks related to the stages starting from the theoretical probabilities of success from a stage to the following. Of course, it is an average because the different stage-risks change for every category of drugs.

In the following scatter plot a positive relationship between the risk related to the development process and the level of underpricing has been identified.

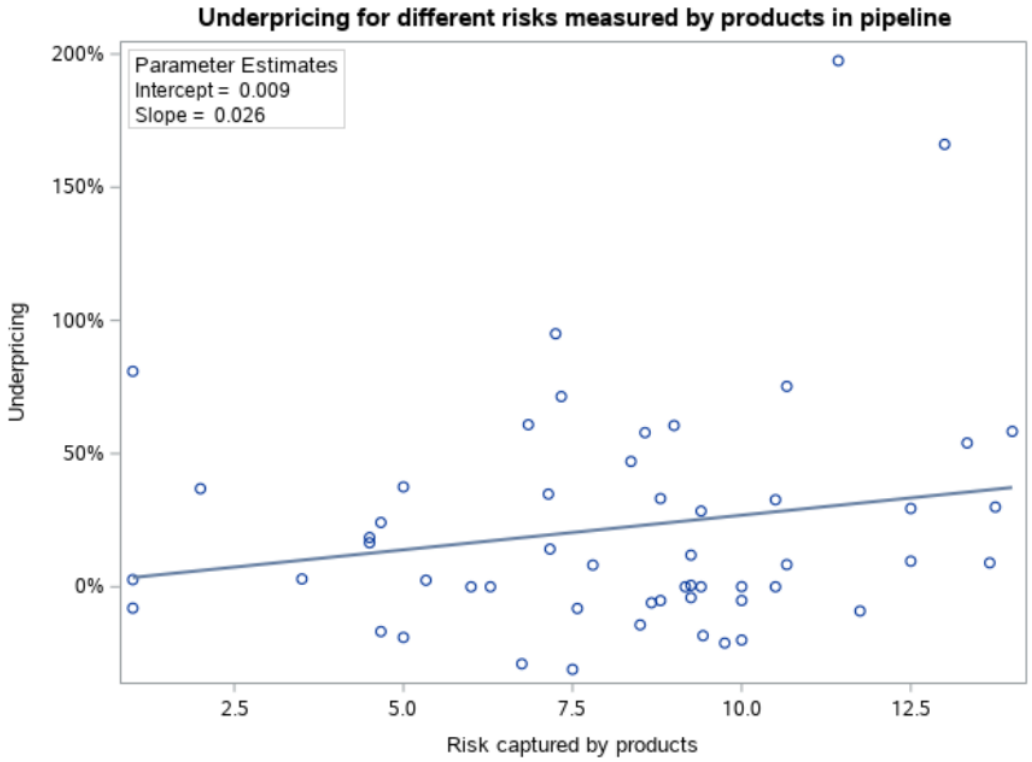


Figure 61 – Scatter plot representing the association of underpricing with risk captured by products in the pipeline

Moreover, I inserted in the dataset other three dummy variables to consider the specificities of stage-firms, grouping firms in *pre-clinical, clinical,* and *market* companies, as shown below.

AB	AC	AD
preclinical	clinical	market
0	1	1
1	0	0
0	1	0

Figure 62 – Dummy variables representing the stage of biotech fimrs

5.2.9. Board composition

In this section of the analysis, I collected data about biotech companies' BOD composition, as follows. I inserted a variable to capture the percentage of independent directors on the board *(% independent directors/BOD*). The summary statistics is shown below.

AV	AW	AX	AY
Bod_members	Key executives	Indipendent directors	% indip directors/bod
8	8	2	0,25
8	6	6	0,75

Figure 63 – BOD composition in the dataset

Board composition

The MEANS Procedure

Variable	Label	Mean	Median	Maximum	Minimum	Std Dev
Bod_members	Number of members in the BOARD	7.30	8.00	10.00	0.00	1.79
Key_executives	Number of key executives	5.33	5.00	10.00	1.00	1.69
Indipendent_directors	Number of indipendent directors in the board	4.42	5.00	7.00	0.00	1.75
___indip_directors_bod	Fraction of indipendent directors over the number of BOD members	0.58	0.63	1.00	0.00	0.20

Figure 64 – Statistics for BOD composition

5.2.10. Board size

The size of the board of directors can be deployed as a proxy for the company's size.

Previous theories state that the smaller the board, the better the monitoring function and therefore, the lower the underpricing level ((Alonso, Azofra, & Lopez-Iturriaga, 2000), (Eisenberg, Sundgren, & Wells, 1998)).

As it can be noticed from the scatter plot below, the higher the board's directors number, the higher the initial return. Hence, previous theories have been confirmed from the Biotech sample. Data regarding the BOD composition have been found on the *Morningstar* website.

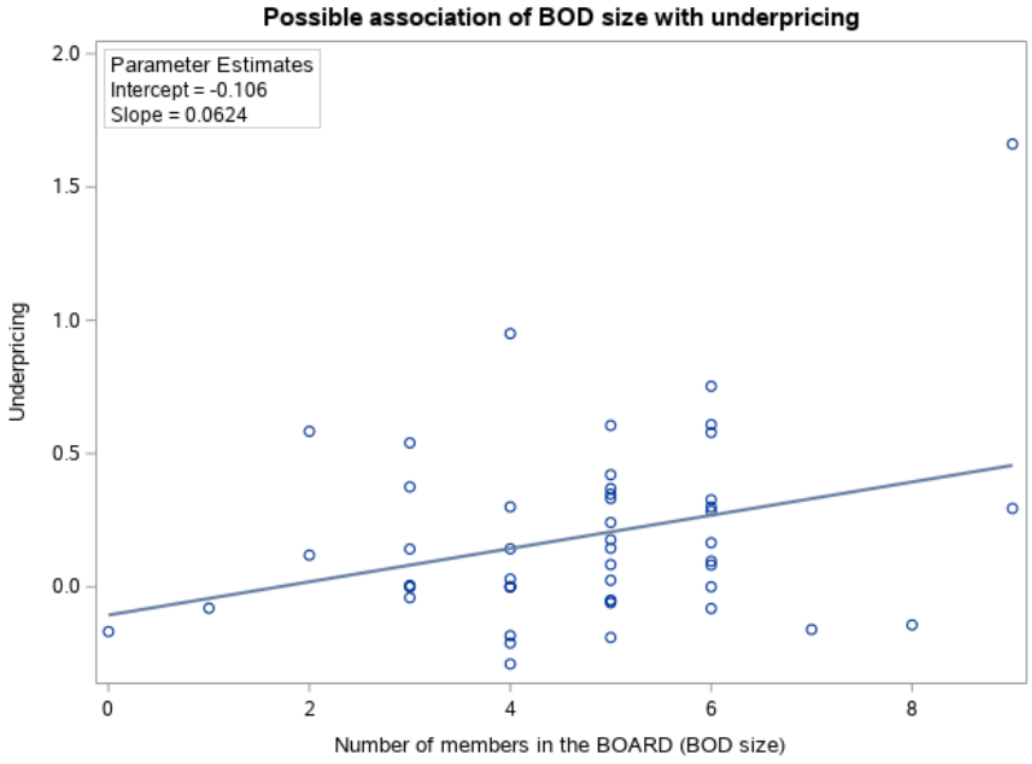


Figure 65 – Scatter plot representing the association of underpricing with number of BOD members

For what regards "Number of key executives" concerning the underpricing level, the scatter plot does not report a significant relation, for this reason, I decided not to display it.

5.2.11. Independent directors in the board

In this regard, there are two conflicting theories in the literature:

1. The higher the number of independent directors in the board, the more precise the monitoring function. In the theory it is expressed that the presence of independent directors can reduce the misalignment of incentives among managers and shareholders and therefore, this can lead to a lower level of underpricing (MacAvoy & Millstein, 1999).
2. The second theory instead explains that a high number of independent directors can cause a high level of underpricing because they make the decision-making process much slower due to the increased burden of control and auditing (Fama & Jensen, 1983).

The scatter plot extrapolated from the sample seems to confirm the second theory.

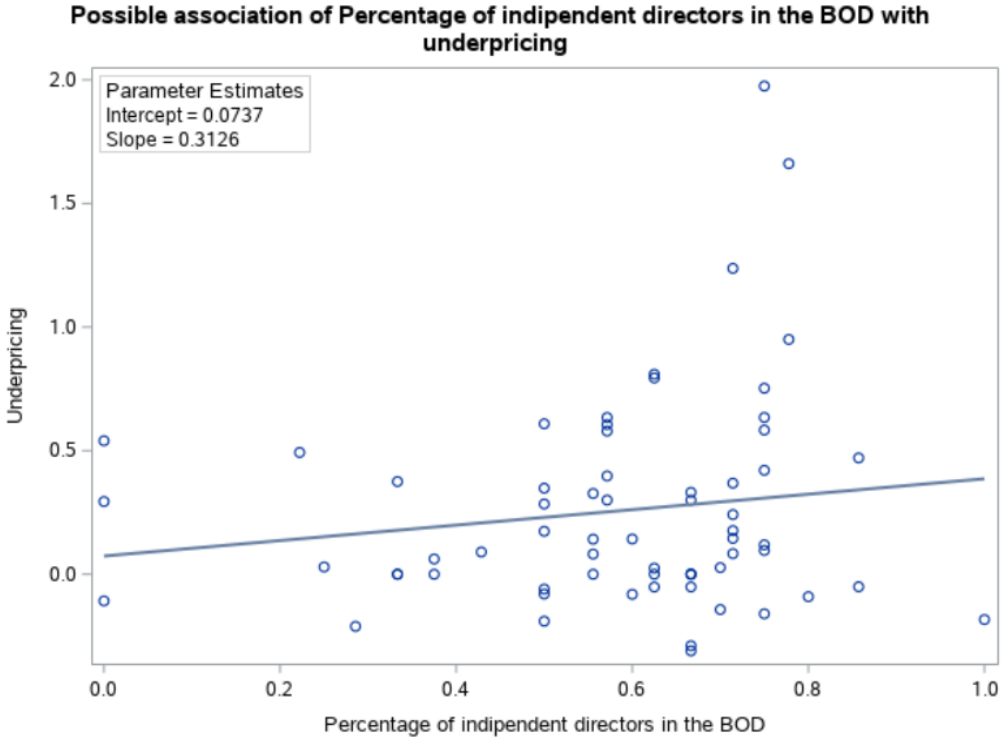


Figure 66 - Scatter plot representing the association of underpricing with % of independent directors

5.2.12. Percentage of institutionals and insiders

Moreover, it is important to focus also on the presence of institutional investors and insiders. Below the statistics for institutional shares and inside ownership is reported. In the literature, institutionals investors are associated as a signal of the good quality of an IPO because they tend to decrease the ex-ante uncertainty around a company. This statement in the regression analysis is confirmed from the biotech sample.

Statistics of ownership

The MEANS Procedure

Variable	Label	Mean	Median	Maximum	Minimum
_insider_ownership	Percentage of insider ownership	2.79	2.15	15.40	0.00
__shares_institutionals	Institutionals shares	34.06	29.56	99.30	0.42

Figure 67 – Statistics for insider and institutionals ownership

From the sample, the relation between underpricing and shares bought by institutions seems positive. A possible explanation of this phenomenon can be found in the article called *"The Moderating Effect of Information Asymmetry on the Signalling Role of Institutional Investors in the Malaysian IPOs"* (Che-Yahya, Abdul-Rahim, & Mohd-Rashid, 2017). The article proves that it is not enough to state that the presence of institutions lowers the underpricing level due to the reduction of asymmetric information. In fact, when the uncertainty around the issuing firm is too high, the presence of institutionals stops being a good signal of the IPO quality. The regression analysis illustrated later in this chapter, confirmed the negative relation between underpricing and shares owned by institutionals.

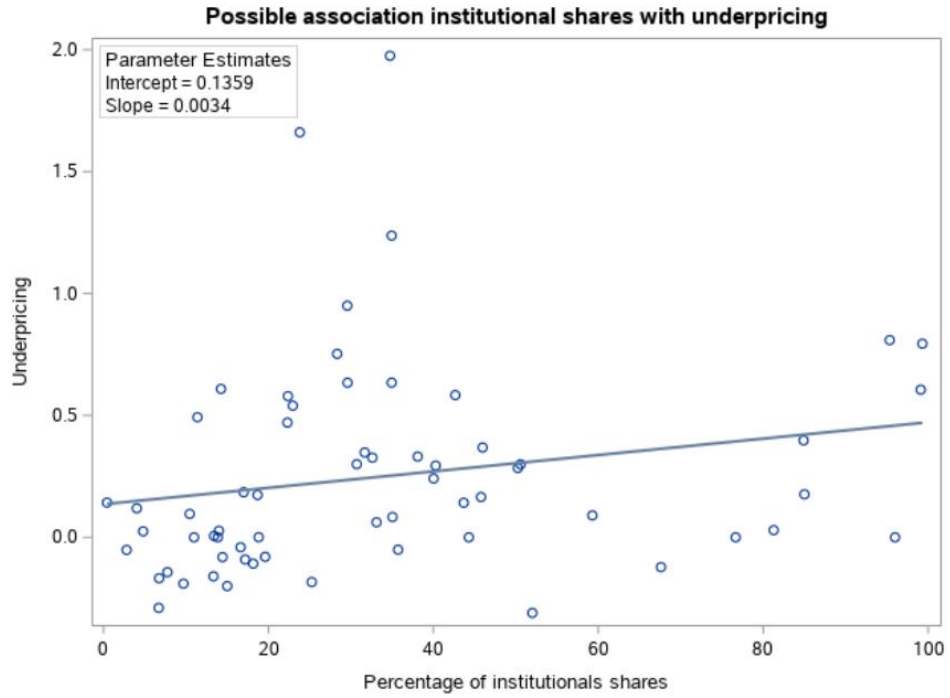


Figure 68 - Scatter plot representing the association of underpricing with % of institutional ownership

In the literature, another signal of the good quality of an IPO is identified in the presence of insider ownership that are the shares owned by directors, managers, and employees (Su, 2003). Investors are more confident in the long-term performance of an IPO given the higher stake of managers and therefore, are more willing to undertake the investment. In

fact, the literature specifies that, the underpricing level should decrease and that, it is proportional to the percentage of insider ownership. This statement seems to be confirmed also from the Biotech sample (see the scatter plot below).

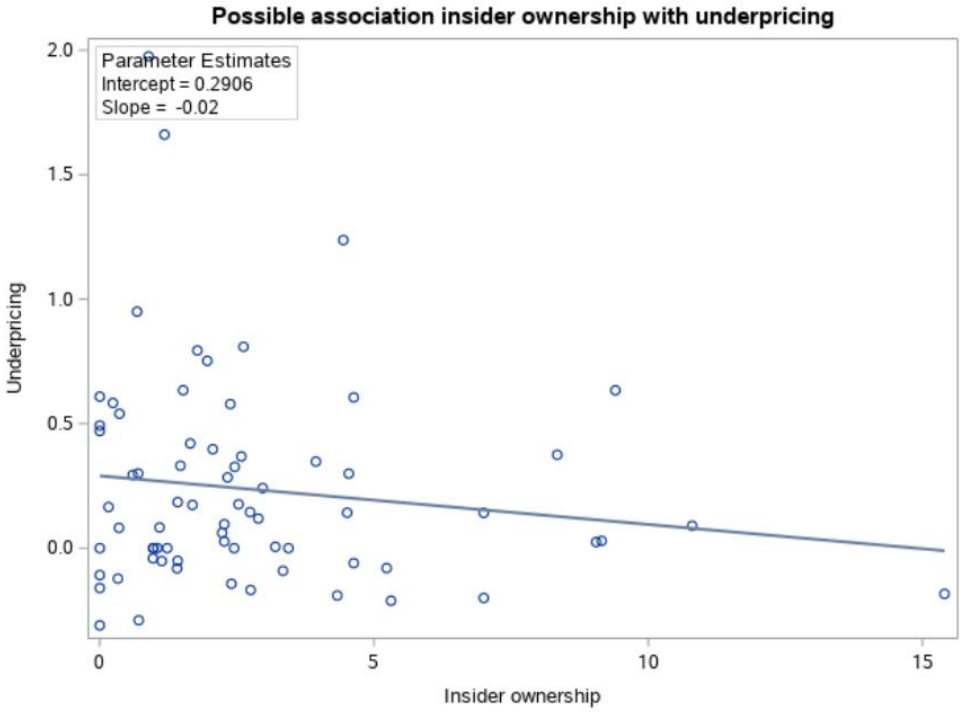


Figure 69 - Scatter plot representing the association of underpricing with insider ownership

5.2.13. Market capitalization

The statistics for market capitalization and the distribution grouped by year are shown below.

Descriptive analysis of market capitalization grouped by year of IPO

The MEANS Procedure

Analysis Variable : Market_Cap_IPO Market_Cap_IPO					
Year_of_ipo	N Obs	Mean	Minimum	Maximum	Std Dev
2017	12	87321659	2928005	173250000	56864500
2018	11	618554767	5929200	5772000000	1710337160
2019	30	107939932	9711250	691650000	122172781
2020	21	340098452	122780000	783983750	186702118

Figure 70 – Statistics for market capitalization grouped by year

Distribution of the market capitalization

The MEANS Procedure

Analysis Variable : Market_Cap_IPO Market capitalization the year of IPO			
Mean	Median	Maximum	Minimum
246381456.75	119640000.00	5772000000.0	2928004.80

Figure 71 - Statistics for market capitalization

The scatter plot constructed from the sample shows a positive relation between underpricing and market capitalization.

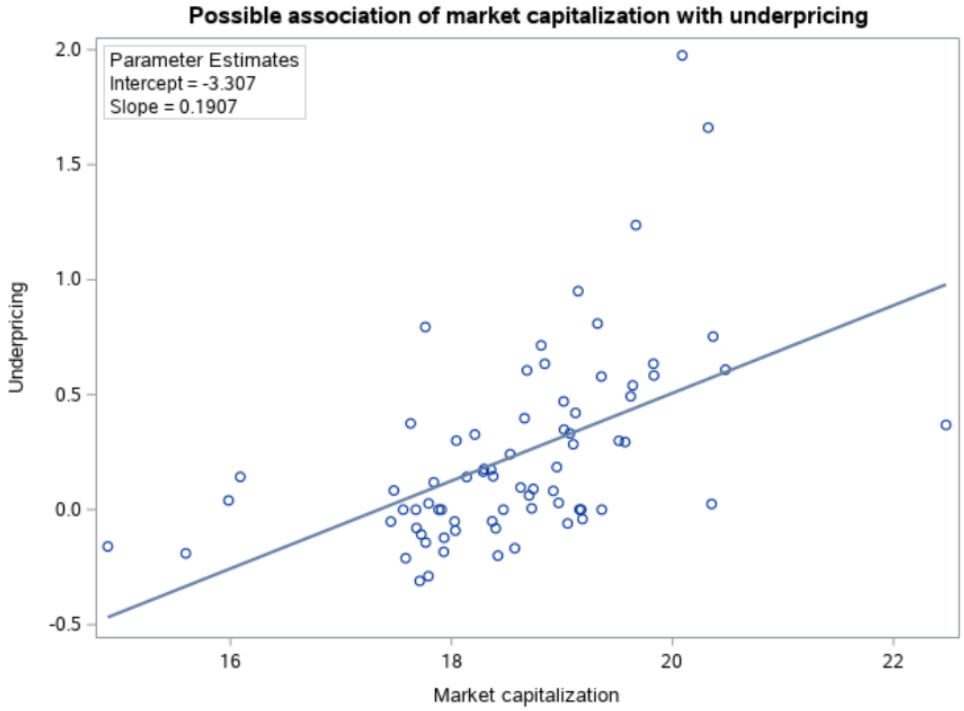


Figure 72 - Scatter plot representing the association of underpricing with market capitalization at IPO

5.2.14. Issue size and shares sold at IPO

In the Biotech sample for every firm, I have calculated the issue size as the shares offered at IPO times the IPO price. The literature explains that underpricing is more significant for smaller issuing sizes. Again, this statement seems not confirmed from the Biotech sample. In fact, the scatter plot highlights a slightly positive relation. The same consideration applies for shares offered.

The statistics from issuing size and shares offered are displayed below.

Statistics of issue size and shares offered

The MEANS Procedure

Variable	Label	Mean	Median	Maximum	Minimum
Issue_Size	Size of the issue	183900195.04	102500002.50	4218000000.0	3485720.00
Shares_IPO	Shares offered at IPO	11117253.31	6733333.50	222000000.00	174286.00

Figure 73 – Statistics for issue size and shares offered at IPO

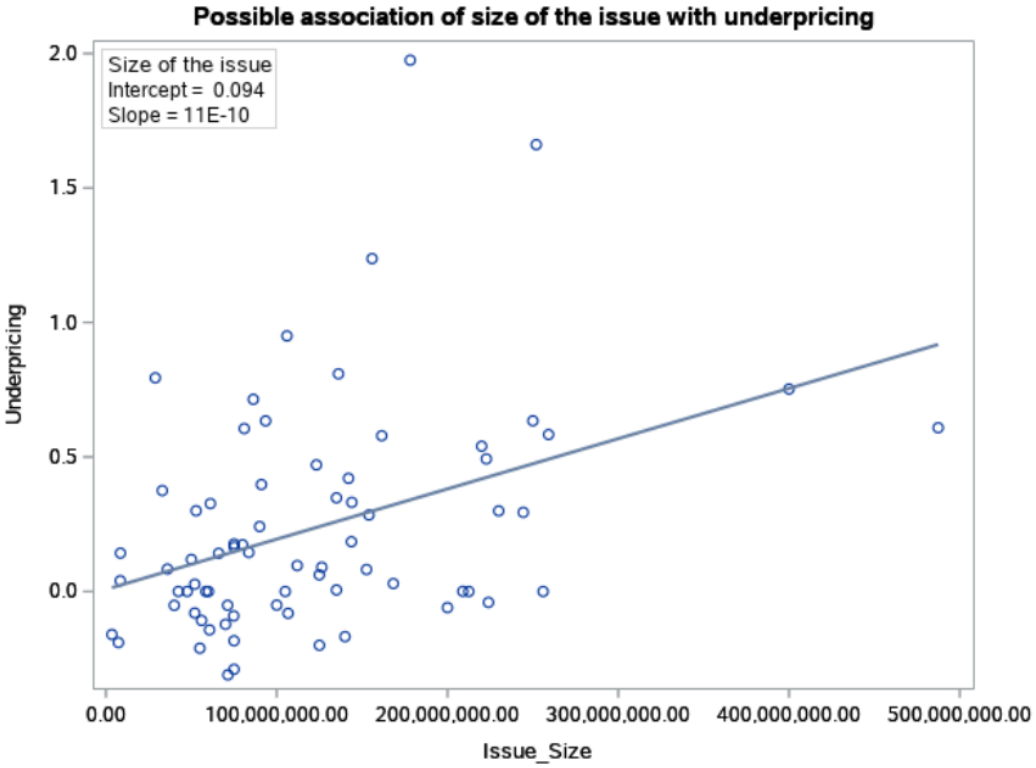


Figure 74 - Scatter plot representing the association of underpricing with Issue size

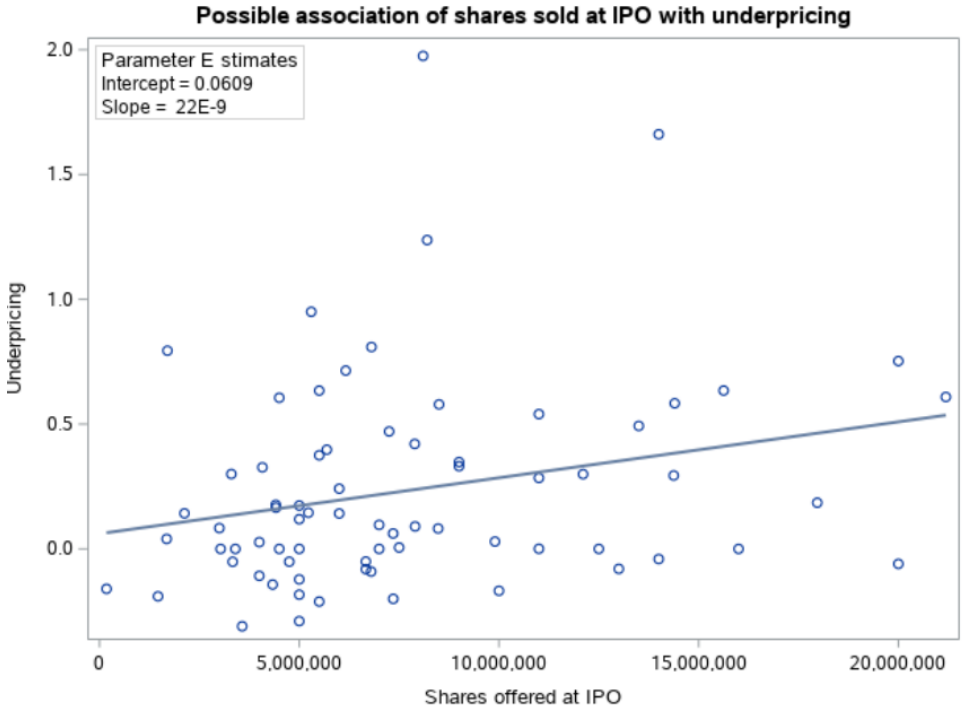


Figure 75 - Scatter plot representing the association of underpricing with shares offered at IPO

5.2.15. Number of risk factors and number of uses in the prospectus

In the second chapter of the thesis work, called "Understanding the theories" it has been said that the ex-ante uncertainty can be captured in several ways. One among them is to look at all the risk factors and the number of uses listed in the IPO prospectus. For this reason, for each biotech firm, I counted the risk factors and the number of uses listed in the S1 form.

Every S1 form lists the risks and use of proceeds. An example is shown below.

Table of Contents

Figure 76 – Example of table of contents of S1 form

The statistics for number of uses and risks are plotted below.

Distribution of number of uses described in the prospectus per year

The MEANS Procedure

Analysis Variable : n_uses Number of uses				
Year of IPO	Mean	Median	Maximum	Minimum
2017	5.30	5.00	8.00	4.00
2018	4.00	4.00	6.00	2.00
2019	3.65	3.50	5.00	2.00
2020	4.15	4.00	6.00	3.00

Figure 77 – Statistics of number of uses grouped by year

It can be seen that the number of uses does not seem interesting to be analyzed. The number is quite constant for every type of firm and does not vary over the years.

Distribution of number of risk factors described in the prospectus per year

The MEANS Procedure

Analysis Variable : n_risk_factors Number of risk factors				
Year of IPO	Mean	Median	Maximum	Minimum
2017	68.90	64.00	96.00	56.00
2018	69.67	70.00	78.00	57.00
2019	71.04	72.00	92.00	32.00
2020	84.08	82.00	116.00	75.00

Figure 78 – Statistics of number of risk factors grouped by year

Instead, the number of risk factors can give important insight into the risk level of the biotech company. Moreover, the median in 2020 increase a lot (82 compared to 64 in 2017) probably due to the instability caused by the pandemic situation.

5.2.16. Capital structure

To calculate the capital structure of biotech firms I searched the balance sheet (of the year of IPO) of the IPO company in the S1 form. I calculated also a column in the dataset referring to D/E to calculate the riskiness of the firm's borrowings. Unfortunately, this data is not able to give us strong insights due to the capital structure of the biotech companies. Biotech firms normally have zero or little debt and high equity.

To calculate equity, I used the invested capital. Instead, to calculate the debt portion of the capital structure, I used the total debt (current liabilities and long-term liabilities).

The statistics for capital structure and for revenue is shown below.

Statistics of Revenue, Debt and Equity

The MEANS Procedure

Variable	Label	Mean	Median	Maximum	Minimum
Rev	Revenue	4029.23	0.00	278397.00	0.00
Debt	DEBT	1109.27	0.80	77446.00	0.00
Equity	EQUITY	2405.08	121.30	155649.00	-194.00

Figure 79 – Statistics of capital structure and firms revenue

In the literature, there is a theory by Nachmanand Noe which explains that capital structure affects underpricing. According to this theory, the portion of debt in the capital structure can signal to investors the good quality of an IPO. In this view, the more a firm gets into debt, the more it is seen as a financially strong company because it is confident about its prospect (Nachman & Noe, 1994).

This theory can not apply to the biotechnology industry. In this sector, the majority of the companies can not be financed with debt. In fact, companies chose to be financed with debt when they are sure to be able to repay interests and the principal, therefore if they have constant revenues which is not the case of biotech firms. Indeed, the biotech industry is a high risk sector in which firms can not be sure to able to pay the debt. For this reason, biotech companies generally receive working capital through equity injections. Equity is a long term investment and it does not need repayments.

5.2.17. R&D expenditures

As biotechnology is an R&D-intensive sector, research and development costs are very high. Most of the R&D expenditures are originated from clinical trials, as stated in the dedicated chapter of the thesis work.

In this section, I calculated the relative R&D expense in the following ways:

- R&D/size of the issue;
- R&D/market capitalization;
- R&D/total assets;

R&D/revenue can not be calculated for the biotech sector given the zero or little revenue.

The statistics for Research & Development is shown below.

Statistics of R&D expenditure

The MEANS Procedure

Analysis Variable : R_D Research and Development			
Mean	Median	Maximum	Minimum
48917567.57	35050000.00	368400000.00	1800000.00

Figure 80 – Statistics of R&D

The association between underpricing and the relative R&D, shown in the scatter plot, seems relevant and negative. This relation confirms that biotech companies can use the R&D expenditure as a credible sign of commitment, reducing underpricing, as stated in the theoretical part of the thesis work.

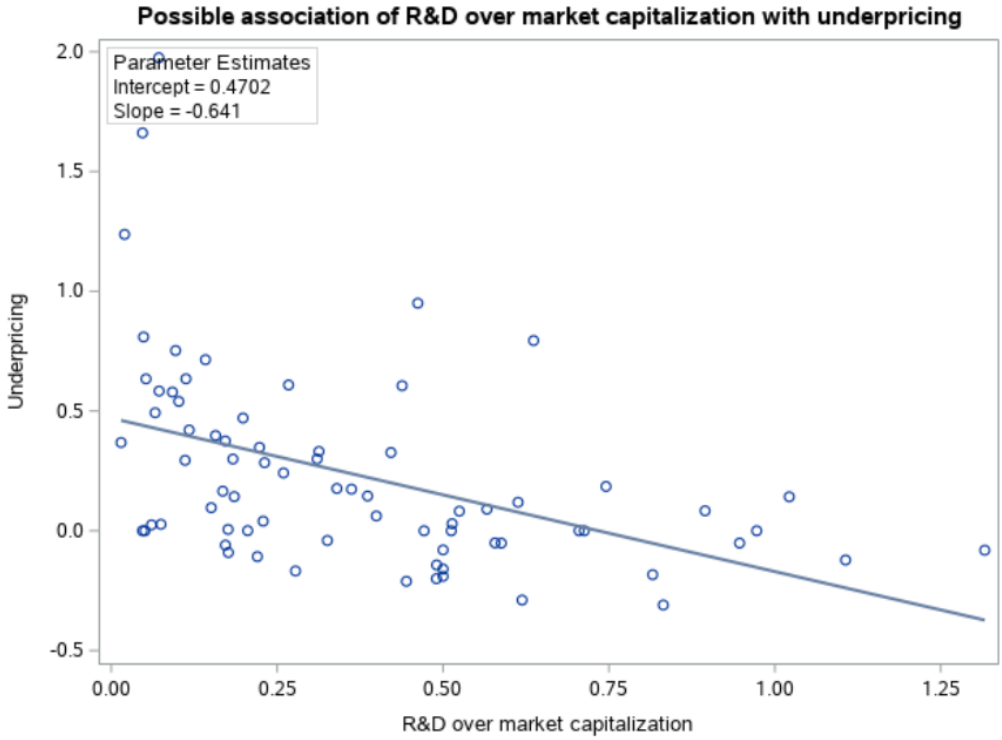


Figure 81 – Scatter plot representing the association of underpricing with relative R&D

5.3. Regression analysis

Model zero

Model zero represents a regression model used as a starting point that I calculated to take into account the most relevant predictors that will be used in the following analysis.

$$
\begin{aligned}
&U \\
&= -\alpha - \beta_1\, Members\ in\ the\ BOD + \beta_2\ Key\ executives \\
&+ \beta_3\, Percentage\ of\ independent\ directors\ in\ the\ BOD + \beta_4\, Insiders \\
&- \beta_5\, Insider\ stake\ compared\ to\ institutional\ stake - \beta_6\, Institutions \\
&+ \beta_7\, Year\ of\ IPO + \beta_8\, Age\ of\ the\ firm + \beta_9\, Year\ 2020\ dummy\ variable \\
&- \beta_{10}\, VC\ backed\ IPO\ dummy\ variable \\
&- \beta_{11}\, Percentage\ of\ patents\ developed\ after\ the\ average\ development\ time \\
&- \beta_{12}\, Number\ of\ patents\ owned\ at\ IPO - \beta_{13}\ Underwriters\ quality \\
&+ \beta_{14}\, Current\ return\ minus\ the\ initial\ return + \beta_{15}\ Ln(Market\ Capitalization) \\
&- \beta_{16}\, Number\ of\ risk\ factors\ described\ in\ the\ prospectus \\
&- \beta_{17}\, Number\ of\ uses\ of\ proceeds\ described\ in\ the\ prospectus \\
&- \beta_{18}\, Relative\ R\&D\ expenditure
\end{aligned}
$$

Some predictors are highly correlated and therefore, they are intentionally left out from "model zero" and will be analyzed separately in the next models.

Especially, the most highly correlated predictors are calculated deploying the *Pearson correlation* in SAS and are listed below:

Coefficienti di correlazione di Pearson Prob > |r| sotto H0: Rho=0 Num. di osservazioni	Bod_members	Indipendent_directors	Key_executives	___indip_directors_bod	Average_Time	NPatentsafterAVG	_patentsafterAVG
Bod_members Bod_members	1.00000 69	0.43771 0.0003 65	0.22073 0.0749 66	-0.00560 0.9647 65	0.21184 0.0956 63	0.14420 0.2595 63	-0.07765 0.5519 61
Indipendent_directors Indipendent directors	0.43771 0.0003 65	1.00000 65	0.20726 0.0976 65	0.88113 <.0001 65	0.03073 0.8157 60	0.22135 0.0892 60	0.12740 0.3363 59
Key_executives Key executives	0.22073 0.0749 66	0.20726 0.0976 65	1.00000 66	0.18585 0.1383 65	0.06969 0.5936 61	0.03428 0.7931 61	0.09287 0.4803 60
___indip_directors_bod % indip directors/bod	-0.00560 0.9647 65	0.88113 <.0001 65	0.18585 0.1383 65	1.00000 65	-0.05862 0.6564 60	0.16165 0.2172 60	0.19369 0.1416 59
Average_Time Average Time	0.21184 0.0956 63	0.03073 0.8157 60	0.06969 0.5936 61	-0.05862 0.6564 60	1.00000 65	0.44535 0.0002 65	0.11335 0.3764 63
NPatentsafterAVG NPatentsafterAVG	0.14420 0.2595 63	0.22135 0.0892 60	0.03428 0.7931 61	0.16165 0.2172 60	0.44535 0.0002 65	1.00000 65	0.13379 0.2959 63
_patentsafterAVG %patentsafterAVG	-0.07765 0.5519 61	0.12740 0.3363 59	0.09287 0.4803 60	0.19369 0.1416 59	0.11335 0.3764 63	0.13379 0.2959 63	1.00000 63

Table 26 - Pearson Correlation Matrix part 1

Coefficienti di correlazione di Pearson Prob > |r| sotto H0: Rho=0 Num. di osservazioni	number_of_underwriters	eu_quality	quality_LeadU	Sum_underwriters_ranking	Shares_IPO	Issue_Size	lnmarketcap	R_D_markcap
number_of_underwriters number_of_underwriters	1.00000 74	-0.03952 0.7745 55	0.40999 0.0003 74	0.92712 <.0001 74	0.11978 0.3094 74	0.46637 <.0001 72	0.54619 <.0001 74	-0.07601 0.5198 74
eu_quality eu_quality	-0.03952 0.7745 55	1.00000 55	0.55964 <.0001 55	0.25828 0.0569 55	0.11326 0.4103 55	0.04377 0.7556 53	-0.01054 0.9391 55	0.17453 0.2025 55
quality_LeadU quality_LeadU	0.40999 0.0003 74	0.55964 <.0001 55	1.00000 74	0.63362 <.0001 74	0.08730 0.4595 74	0.22133 0.0617 72	0.44192 <.0001 74	0.07089 0.5484 74
Sum_underwriters_ranking Sum_underwriters_ranking	0.92712 <.0001 74	0.25828 0.0569 55	0.63362 <.0001 74	1.00000 74	0.15182 0.1966 74	0.47967 <.0001 72	0.60339 <.0001 74	0.02673 0.8211 74
Shares_IPO Shares_IPO	0.11978 0.3094 74	0.11326 0.4103 55	0.08730 0.4595 74	0.15182 0.1966 74	1.00000 74	0.89295 <.0001 72	0.54601 <.0001 74	-0.22486 0.0541 74
Issue_Size Issue_Size	0.46637 <.0001 72	0.04377 0.7556 53	0.22133 0.0617 72	0.47967 <.0001 72	0.89295 <.0001 72	1.00000 72	0.83007 <.0001 72	-0.43172 0.0002 72
lnmarketcap lnmarketcap	0.54619 <.0001 74	-0.01054 0.9391 55	0.44192 <.0001 74	0.60339 <.0001 74	0.54601 <.0001 74	0.83007 <.0001 72	1.00000 74	-0.45814 <.0001 74
R_D_markcap R&D/markcap	-0.07601 0.5198 74	0.17453 0.2025 55	0.07089 0.5484 74	0.02673 0.8211 74	-0.22486 0.0541 74	-0.43172 0.0002 72	-0.45814 <.0001 74	1.00000 74

Table 27 - Pearson Correlation Matrix part 1

1. The portion of independent directors in the BOD (calculated as the fraction of the number of independent directors in the board and the total number of board members) and the number of independent directors in the board are highly correlated (0,88113) and the correlation highly significant (p value < 0,0001):
2. The average time for developing a patent is moderately correlated with the number of patents a firm develops after the average time ("recent patents") in fact, the Pearson correlation is 0,44535 and it is highly significant (p value equals 0,0002).
3. The number of underwriters that are part of the *underwriter syndicate* in the IPO process is highly correlated with the sum of the rankings given to each underwriter in the syndicate, according to Professor J. Ritter. In fact, the correlation is 0,9271. Moreover, the quality of the lead underwriter in the syndicate, calculated according

to J. Ritter, is highly correlated to the sum of the underwriters ranking (0,6336). In addition, the quality of the lead underwriter is highly correlated also with quality of underwriters, according to the classification described in the "List of underwriters of European IPOs (update 2017)" accessible from J. Ritter website.

4. Shares offered at IPO shows a high correlation (0,8929) with the issue size of IPO calculated as the offering price times the number of shares sold.
5. The natural logarithm of market capitalization (calculated as the price at the closing first day times the shares offered) and the relative R&D expenditure (calculated as the R&D expenditure over the market capitalization) show a negative, moderate correlation (-0,4581).
6. Market capitalization at IPO is highly correlated with the issuing size: 0,83.

The overall model shows a p value equal to 0,0011 and therefore, it is significant. In “model zero” significant predictors can be identified in the portion of independent directors in the board, in the age of the firm when the IPO process took place (calculated as the difference from the IPO year and the foundation year), in the current return except the initial returns and in the market capitalization.

Later, the six regression models are discussed. Every model is displayed to explain a characteristic of the Biotech IPOs. Moreover, at the end of the analysis a model containing all the relevant predictors will be displayed.

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	4.48934	0.24941	5.53	0.0011
Error	14	0.63179	0.04513		
Corrected Total	32	5.12113			

Root MSE	0.21243	R-Square	0.8766
Dependent Mean	0.24301	Adj R-Sq	0.7180
Coeff Var	87.41632		

Parameter Estimates						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-196.00211	166.68752	-1.18	0.2593
Bod_members	Bod_members	1	-0.04237	0.03888	-1.09	0.2942
Key_executives	Key executives	1	0.03112	0.03972	0.78	0.4464
___indip_directors_bod	% indip directors/bod	1	0.64736	0.27270	2.37	0.0325
_insider_ownership	%insider ownership	1	0.00884	0.01810	0.49	0.6329
insider_institutionals	insider/institutionals	1	-0.38332	0.19714	-1.94	0.0722
__shares_institutionals	% shares institutionals	1	-0.00098553	0.00238	-0.41	0.6852
Year_of_ipo	Year_of_ipo	1	0.09605	0.08265	1.16	0.2647
Age	Age	1	0.03514	0.01561	2.25	0.0410
_2020	2020	1	0.34097	0.19871	1.72	0.1082
VC	VC	1	-0.31921	0.18687	-1.71	0.1097
_patentsafterAVG	%patentsafterAVG	1	-0.66410	0.15680	-4.24	0.0008
Number_of_patents_at_Ipo	Number_of_patents_at_Ipo	1	-0.00040958	0.00063038	-0.65	0.5264
eu_quality	eu_quality	1	-0.03065	0.15656	-0.20	0.8476
return_except_underpricing	return except underpricing	1	0.13884	0.03395	4.09	0.0011
lnmarketcap	lnmarketcap	1	0.17016	0.05948	2.86	0.0126
n_risk_factors	n risk factors	1	-0.00774	0.00444	-1.74	0.1031
n_uses	n uses	1	-0.02987	0.05738	-0.52	0.6108
R_D_markcap	R&D/markcap	1	-0.08102	0.24464	-0.33	0.7454

Table 28 – Regression Analysis MODEL ZERO

Every predictor analyzed will be described in the next table:

PREDICTOR	NAME IN Sas	DESCRIPTION AND SOURCE
Number of members in the board of directors	Bod_members	The number of members composing the BOD has been found on the *Morningstar* Website.
Number of key executives	Key_executives	The number of the firm's key executives has been found on the *Morningstar* Website.

Number of independent directors in the board of directors	Independent_directors	The number of Independent directors in the board of directors of a company has been found on the *Morningstar* Website.
Percentage of independent directors in the board	___indip_directors_bod	The portion has been calculated dividing the number of independent directors over the number of BOD members.
Insider ownership	_insider_ownership	Stake of the company retained by insiders. The percentage has been found on the *Morningstar* Website, in the *ownership* section.
Institutional ownership	__shares_institutionals	Stake of the company retained by institutional investors. The percentage has been found on the *Morningstar* Website, in the *ownership* section.
Portion of shares bought by mutual funds	__shares_funds	The percentage has been found on the *Morningstar* Website, in the *ownership* section.
The portion of insider ownership with respect to the portion of institutional ownership	Insiders_institutionals	The fraction has been calculated dividing the number of insiders shares over the amount of institutional shares.
Year of IPO	Year_of_ipo	The year in which a company does an IPO can be found in the prospectus.
Year of Foundation	Year_of_foundation	The year of foundation generally can be found on the company's website, but for some companies the data is missing.
Age of the firm when the IPO	Age	The age of a firm when the IPO takes place has been calculated subtracting from the

process took place		year of IPO, the year of company foundation.
Dummy variable: 2020	_2020	If the company did an IPO during 2020, a flag has been added in the _2020 column in the dataset.
Dummy variable: VC	VC	If the IPO was backed by venture capitalists, a flag has been added in the VC column in the dataset. I found the list of IPO backed by VC in Professor Ritter's website.
Average Time	Average_time	It is the calculation of the average time for developing a patent, of each firm. Data relating the number of patents a firm developed in a particular year have been found on the WIPO website.
Number of patents after the average time of patent development	NPatentsAfterAVG	It is the amount of patents a firm developed after the average development time and therefore, it shows how many patents are "new" and more risky.
Portion of patents developed after the average development time	_PatentAfterAVG	It is the calculation of the number of "new patents" or "risky patents" over the total number of patents the firm developed from the year of foundation to the IPO year.
Number of patents the IPO year	Number_patents_at_IPO	It is the number of patents developed by the firm from the year of foundation until the year in which the company started the IPO process.
Number of patents the year	N_patents_the_year_before	It is the number of patents developed by the firm from the year of foundation until the year before the IPO process started.

before the IPO took place		
Quality of the underwriters	Eu_quality	It is the ranking of underwriter quality proceeds-weighted, according to the "List of underwriters of European IPOs (update 2017)", that I found of Professor Ritter website.
Sum of underwriters ranking	Sum_underwriters_ranking	It is the sum of the ranking of every underwriter composing the syndicate, according to Ritter's ranking. Therefore, the higher the sum, the higher the overall quality of the syndicate.
Number of risk factors described in the prospectus	N_risks	It is the number of all the potential risks entailing the business, described in the S1 form.
Number of uses of the proceeds described in the prospectus	N_uses	It is the number of the activities the firm will start thanks to the financing, and it is visible in the S1 form.
Current return net of underpricing	Return_except_underpricing	It is the calculation of the actual return: $$\frac{P\ current - P\ offer}{P\ offer}$$ At the current return I subtracted the initial return.
Market capitalization at IPO	lnmarketcap	I calculated the natural logarithm of the market capitalization at IPO, using the next formula: $$Market\ Capitalization = share\ P\ at\ the\ closing\ day \cdot number\ of\ shares\ sold\ at\ IPO$$

Relative R&D Expense	RD/markcap	It is the R&D expense in the IPO year, divided by the market capitalization.

Models are ordered from the least significant (lowest overall p value) to the most significant one.

Model one

$$U = -\alpha + \beta_1\ Issue\ size\ - \beta_2\ Insider\ stake\ compared\ to\ institutional\ stake + \beta_3\ Patents\ the\ year\ before\ IPO + \beta_4\ Current\ return\ net\ of\ underpricing + \beta_5\ VC\ dummy\ variable$$

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	5	5.46591	1.09318	9.61	<.0001
Error	49	5.57245	0.11372		
Corrected Total	54	11.03836			

Root MSE	0.33723	**R-Square**	0.4952
Dependent Mean	0.27071	**Adj R-Sq**	0.4437
Coeff Var	124.57075		

Parameter Estimates						
Variable	**Label**	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	Intercept	1	-0.15306	0.15745	-0.97	0.3358
Issue_Size	Issue_Size	1	1.666936E-9	4.32248E-10	3.86	0.0003
insider_institutionals	insider/institutionals	1	-0.43239	0.18315	-2.36	0.0223
N_patents_the_year_before	N patents the year before	1	0.00134	0.00058633	2.29	0.0264
return_except_underpricing	return except underpricing	1	0.13237	0.03053	4.34	<.0001
VC	VC	1	0.10364	0.15034	0.69	0.4938

The first model displayed is statistically significant, in fact, it can be seen that the p-value is lower than 0,0001. I decided to insert both the R-Square and the R-Square adjusted, but I have always referred principally to the adjusted one, given that, it does not increase, increasing the number of predictors analyzed.

The first model explains only 44,37% of the variability but I decided to display it to show the relation between issue size and underpricing, not displayed in the following models due

to the high correlation with market capitalization. Moreover, the model gives an important insight about the number of patents developed. More in the detail:

- Size of the issue: the relation is significant and positive. Therefore, the higher the issue size, the higher the underpricing level;
- $\frac{\text{Insider ownership}}{\text{institutional ownership}}$ has been used as a proxy to understand the portion of insider ownership. The relation is negative and significant in this model. Therefore, as explained above in this chapter, the presence of a high stake of insider ownership with respect to the institutional one can be used by biotech firms to signal the good quality of the IPO and the strong commitment for the future, leading to a reduction in the underpricing;
- Patents developed until the year before the IPO: in the theoretical part has been said that patents can be used by firms to signal the commitment for the future and decrease the ex-ante uncertainty around the company. In the biotech sector, it has been seen in the previous models that underpricing decreases when patents are consolidated and increases when patents developed are new because are riskier. Therefore, a high number of patents is not enough to decrease the uncertainty and decrease underpricing. In fact, the higher the number of patents, the higher the initial returns;
- Venture capitalists: the presence of venture capitalists is not significant, probably due to the limited data of firms collected. In fact, near the total number of IPOs have been backed by VC and therefore, there were only a few data of IPO without VCs.

Model two

$$U = -\alpha + \beta_1\, 2020 + \beta_2\, Ln\,(Market\ capitalization) + \beta_3\, Current\ return\ net\ of\ underpricing - \beta_4\, Quality\ of\ the\ underwriters\ syndicate$$

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	6.64742	1.66185	19.67	<.0001
Error	69	5.83085	0.08451		
Corrected Total	73	12.47826			

Root MSE	0.29070	R-Square	0.5327
Dependent Mean	0.23279	Adj R-Sq	0.5056
Coeff Var	124.87566		

Parameter Estimates						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-2.68947	0.69647	-3.86	0.0003
_2020	2020	1	0.21678	0.08865	2.45	0.0170
lnmarketcap	lnmarketcap	1	0.16846	0.04149	4.06	0.0001
return_except_underpricing	return except underpricing	1	0.13042	0.02431	5.36	<.0001
Sum_underwriters_ranking	Sum_underwriters_ranking	1	-0.01537	0.00671	-2.29	0.0251

The variance explained in the second model is 50.6%. This model depicts that:

- The dummy variable 2020 is highly significant and positive. Therefore, the year 2020 is characterized by a higher level of underpricing with respect to previous years. 2020 was characterized by great uncertainty around capital markets;
- Market capitalization is highly significant and positive. Therefore, the higher the capitalization of biotech firms, the higher the underpricing level;
- Return net of underpricing: this relation is again highly significant and positive in fact, the higher the risk around the company, the higher the underpricing;
- Quality of the underwriter syndicate: this predictor has been used as a proxy for the underwriters' quality. To obtain it, I summed the ranking (according to Carter and Manaster and the review made by J. Ritter) of the lead underwriter and all the underwriters participating in the syndicate. The association is significant and negative. Therefore, the higher the ranking (the syndicate quality), the lower the level of underpricing.

Model three

$$U = -\alpha - \beta_1\, Underwriters\ quality + \beta_2\, Ln\,(market\ capitalization) + \beta_3\, Current\ return\ net\ of\ underpricing + \beta_4\, Risk\ degree\ of\ products\ in\ development$$

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	5.17583	1.29396	12.34	<.0001
Error	39	4.08958	0.10486		
Corrected Total	43	9.26542			

Root MSE	0.32382	R-Square	0.5586
Dependent Mean	0.26774	Adj R-Sq	0.5133
Coeff Var	120.94742		

Parameter Estimates						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-4.13482	0.96764	-4.27	0.0001
eu_quality	eu_quality	1	-0.29520	0.14125	-2.09	0.0432
lnmarketcap	lnmarketcap	1	0.22750	0.05096	4.46	<.0001
return_except_underpricing	return except underpricing	1	0.11946	0.03156	3.79	0.0005
totalrisk_nproducts	totalrisk/nproducts	1	0.02146	0.01548	1.39	0.1735

I displayed this model, because of the strong insight it gives about the quality of underwriters. In this model, I used as a proxy for underwriters' quality, the more recent ranking method, described before. It can be seen that the predictor called eu_quality is significant and negative. Therefore, the asymmetric theory of underpricing is confirmed for the biotech industry. Indeed, the higher the quality of the investment banks, the lower the initial returns. The underwriters that have a better reputation, are used to signal to investors the good quality of the biotech IPO.

The other predictors in model four are not described because they have already been described before.

Model four

$$U = -\alpha + \beta_1\, Mutual\ Funds - \beta_2\, Institutionals - \beta_3\, Memebers\ in\ the\ BOD + \beta_4\, Independent\ directors - \beta_5\, Key\ executives + \beta_6\, Ln\,(Market\ Capitalization) + \beta_7\, Current\ return\ net\ of\ underpricing$$

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	6.62950	0.94707	10.98	<.0001
Error	55	4.74560	0.08628		
Corrected Total	62	11.37510			

Root MSE	0.29374	R-Square	0.5828
Dependent Mean	0.26568	Adj R-Sq	0.5297
Coeff Var	110.56202		

Parameter Estimates						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-3.13379	0.64793	-4.84	<.0001
__shares_funds	% shares funds	1	0.00532	0.00443	1.20	0.2348
__shares_institutionals	% shares institutionals	1	-0.00409	0.00182	-2.25	0.0287
bod_members	bod_members	1	-0.00694	0.03113	-0.22	0.8243
indipendent_directors	indipendent directors	1	0.04822	0.02410	2.00	0.0504
key_executives	key executives	1	-0.03850	0.02410	-1.60	0.1159
lnmarketcap	lnmarketcap	1	0.18856	0.03441	5.48	<.0001
return_except_underpricing	return except underpricing	1	0.12313	0.02786	4.42	<.0001

I displayed this model (explaining the 52.97% of the variability), instead, for the following reason:

- Shares of institutionals: the relation is significant and negative. In fact, underpricing can be used to attract non-institutional investors that buy shares at a lower price. The only presence of institutional investors can signal the good quality of an IPO, attracting investors. In this context, it is not necessary anymore to decrease the IPO price. In fact, the higher the institutional shares, the lower the underpricing level.

The only predictor in this model that has not been described before is “Funds Shares”. In the Morningstar website, in the Ownership section, are listed all the mutual funds that invested in the IPO shares of the company. In the model the relation is not significant.

In the literature there are two opposite theories concerning the presence of mutual funds in IPOs. The first one is related to the conflict of interest because it explains that often, underwriters have affiliated mutual funds and therefore, can use their discretionary power in allocating shares to their own mutual funds, benefiting themselves and receiving extra commissions (Ritter & Zhang, 2007). The second theory, instead, exposes that underwriters, may use the mutual funds in their control to benefit the IPO firm and

therefore, the IPO investors (Gaspar, Massa, & Matos, 2006). These two theories can not be confirmed in this model.

Model five

$$U = -\alpha + \beta_1\, Ln\,(market\ capitalization) + \beta_2\, Current\ return\ net\ of\ underpricing + \beta_3\, Recent\ (risky)\ patents + \beta_4\, Risk\ degree\ of\ products\ in\ development$$

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	5.88921	1.47230	17.64	<.0001
Error	43	3.58951	0.08348		
Corrected Total	47	9.47872			

Root MSE	0.28892	R-Square	0.6213
Dependent Mean	0.22621	Adj R-Sq	0.5861
Coeff Var	127.72253		

Parameter Estimates						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-4.36473	0.81350	-5.37	<.0001
lnmarketcap	lnmarketcap	1	0.22919	0.04300	5.33	<.0001
return_except_underpricing	return except underpricing	1	0.12293	0.02794	4.40	<.0001
NPatentsafterAVG	NPatentsafterAVG	1	0.00162	0.00067143	2.41	0.0202
totalrisk_nproducts	totalrisk/nproducts	1	0.01731	0.01305	1.33	0.1918

The third model is statistically significant and explains 58.61% of the variability. I displayed this model because of the strong implication it has regarding the presence of patents. As stated in this chapter, patents can be used by biotech firms to decrease the ex-ante uncertainty around the firm before going public, does leading to a reduction in the underpricing. As described before, I used the "number of recent patents", that is the number of patents developed after the average development time, as a proxy for the quality of patents. In fact, a high number of recent patents implies that patents are not mature yet; that they are not consolidated. Generally, a young patent can be highly risky. In the detail:

- Number of recent patents: the relation is significant and positive. Therefore, the higher the risk around patents, the higher the underpricing level;
- Market capitalization and current return are significant and they have already been described before;
- Risk captured by the products in the pipeline: as described before in this chapter, I used the total risk of the pipeline (calculated multiplying the number of products in a phase time its risk) over the total number of products as a proxy for the riskiness of products. This relation is positive, therefore the higher the risk, the higher the underpricing, but in this model, it is not significant.

Model six

$$U = + \alpha - \beta_1 \, Relative \; R\&D + \beta_2 \, Independent \; directors + \beta_3 \, Current \; return \; net \; of \; underpricing + \beta_4 \, 2020 + \beta_5 \, Recent \; (\text{risky}) \; patents - \beta_6 \; Key \; executives$$

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	7.04837	1.17473	15.02	<.0001
Error	53	4.14623	0.07823		
Corrected Total	59	11.19460			

Root MSE	0.27970	R-Square	0.6296
Dependent Mean	0.27109	Adj R-Sq	0.5877
Coeff Var	103.17567		

Parameter Estimates						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	0.11078	0.16839	0.66	0.5135
R_D_markcap	R&D/markcap	1	-0.57468	0.14728	-3.90	0.0003
Indipendent_directors	Indipendent directors	1	0.04579	0.02173	2.11	0.0398
return_except_underpricing	return except underpricing	1	0.11626	0.02379	4.89	<.0001
_2020	2020	1	0.22994	0.09510	2.42	0.0191
NPatentsafterAVG	NPatentsafterAVG	1	0.00163	0.00065339	2.49	0.0158
Key_executives	Key executives	1	-0.00733	0.02270	-0.32	0.7481

Model six explains more variance compared to the previous one, 58.77%. The most important insight this model gives us is that R&D can be used by biotech firms to signal

the good quality of the IPO and reducing the ex-ante uncertainty around the firm leading to a lower underpricing. More in the detail:

- Relative R&D (calculated as R&D expense over market capitalization, as stated before): the higher the R&D, the lower the underpricing because the relation between underpricing and R&D expense is significant and negative;
- Number of independent directors in the BOD: the predictor is significant (not highly significant), and states that the higher the number of independent directors, the higher the underpricing, confirming the second theory about the independent directors in the board, described in this chapter. In fact, it has been said that the higher the number, the higher the underpricing due to a slowdown in the decision-making process;
- Return and 2020 dummy variable, already explained before, are both significant and positive;
- Number of recent patents developed by IPO firms: it has been used as a proxy to capture the risk around a firm. The relation is significant and positive and, therefore, the higher the number of recent patents (not consolidated ones), the higher the uncertainty around the company starting the IPO process and the higher the underpricing level (this predictor will be better explained in the next model);
- Number of key executives in the BOD: not significant in this model.

Final model

$$\begin{aligned} U = +\alpha + \beta_1\ & 2020\ Dummy\ variable + \beta_2\ Ln\ (Market\ Capitalization) \\ & + \beta_3\ Current\ return\ net\ of\ underpricing \\ & + \beta_4\ Quality\ of\ the\ underwriters\ syndicate - \beta_5\ Relative\ R\&D \\ & + \beta_6\ Indipendent\ directors - \beta_7\ Recent\ (risky)\ patents \\ & + \beta_8\ Patents\ the\ year\ before\ IPO + \beta_9\ Underwriters\ quality \\ & + \beta_{10}\ Institutionals \\ & - \beta_{11}\ Insider\ stake\ compared\ to\ institutional\ stake \end{aligned}$$

The last model displayed is comprehensive of the most significant predictors found in the previous models (predictors highly correlated that have been described before are not in the last model) and explains the 66,49% of the variability.

Analisi della varianza					
Origine	**DF**	**Somma dei quadrati**	**Media quadratica**	**Valore F**	**Pr > F**
Modello	11	6.63258	0.60296	8.03	<.0001
Errore	28	2.10156	0.07506		
Totale corretto	39	8.73414			

Radice MSE	0.27396	**R-quadro**	0.7594
Media dip.	0.32141	**R-quadro corr**	0.6649
Coeff var	85.23713		

Stime dei parametri						
Variabile	**Etichetta**	**DF**	**Stima dei parametri**	**Errore standard**	**Valore t**	**Pr > |t|**
Intercept	Intercept	1	-1.81128	1.24028	-1.46	0.1553
_2020	2020	1	0.18272	0.15709	1.16	0.2546
lnmarketcap	lnmarketcap	1	0.09188	0.06965	1.32	0.1978
return_except_underpricing	return except underpricing	1	0.09589	0.03075	3.12	0.0042
Sum_underwriters_ranking	Sum_underwriters_ranking	1	0.00634	0.01054	0.60	0.5526
R_D_markcap	R&D/markcap	1	-0.52702	0.23770	-2.22	0.0349
Indipendent_directors	Indipendent directors	1	0.03623	0.03110	1.16	0.2540
NPatentsafterAVG	NPatentsafterAVG	1	-0.00401	0.00228	-1.76	0.0891
N_patents_the_year_before	N patents the year before	1	0.00475	0.00178	2.67	0.0124
eu_quality	eu_quality	1	0.02676	0.15752	0.17	0.8663
__shares_institutionals	% shares institutionals	1	0.00110	0.00227	0.48	0.6323
insider_institutionals	insider/institutionals	1	-0.06954	0.17831	-0.39	0.6995

CHAPTER 6- Conclusions

6. Analysis conclusions

6.1. Descriptive analysis of underpricing

As explained in the analysis chapter, I constructed a sample of Biotech IPOs and used SAS software to run the analysis.

Firstly, I focused on proving the already existing theories for traditional firms that apply also to the biotech sector, and then, I focused my attention on discovering what could explain the underpricing of biotech IPOs.

The first relevant characteristic noticed is that the average underpricing extrapolated from the sample is 23% (perfectly in line with the underpricing of traditional IPOs). However, from a more detailed analysis it can be understood that the value is pushed up by the year 2020 showing extreme results, as shown in the following table:

Analysis of Underpricing

The MEANS Procedure

Analysis Variable : Underpricing						
Year_of_ipo	N Obs	Mean	Median	Minimum	Maximum	Variance
2017	12	0.13	0.09	-0.18	0.71	0.06
2018	11	0.10	0.00	-0.29	0.63	0.09
2019	30	0.11	0.04	-0.31	0.81	0.08
2020	21	0.54	0.49	-0.04	1.98	0.30

Table 29 – Underpricing statistics

Considering only the years before 2020, the average underpricing is about 11% which is lower than traditional underpricing (about 20%). The analysis wants to investigate why.

To confirm the hypothesis that the average underpricing in 2020 is statistically different from the average underpricing in previous years, I run a t-test. The t-test has been devoted to checking the underpricing in 2020 in the sample compared to the average value of 2018.

The null hypothesis is expressed below:

- H0: $\mu_0 = 0{,}1048$

The average underpricing of the sample, in 2018, has been 0.1048.

The result of the t-test, using SAS, follows:

The TTEST Procedure

Variable: Underpricing2020 (Underpricing2020)

N	Mean	Std Dev	Std Err	Minimum	Maximum
21	0.5374	0.5457	0.1191	-0.0406	1.9750

Mean	95% CL Mean		Std Dev	95% CL Std Dev	
0.5374	0.2890	0.7858	0.5457	0.4175	0.7880

DF	t Value	Pr > |t|
20	3.63	0.0017

Table 30 – t-test

Analyzing the previous table, it can be seen that the t value is 3,63 and that the p-value (0,0017) is lower than α (0,05) and therefore, I reject the null hypothesis of averages equality. In fact, average underpricing in 2020 is statistically different from 0.1048 (average in 2018).

The same conclusion can be reached visually by looking at the next confidence interval:

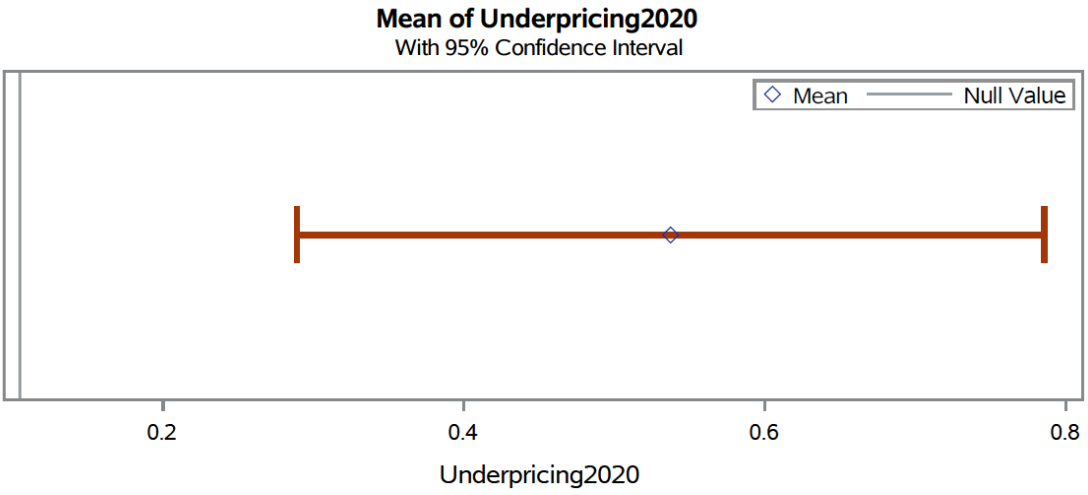


Figure 82 – confidence interval

In fact, it can be noticed that the vertical line referring to μ_0 is not included in the confident interval.

Moreover, it is necessary also to check the validity of the test before concluding that the average underpricing in 2020 has been different compared to the one in previous years. For this purpose, SAS analysis offers two charts (distribution histogram and the Q-Q plot) in

which the validity check can be done. For the sake of simplicity, I decided to display only one of them:

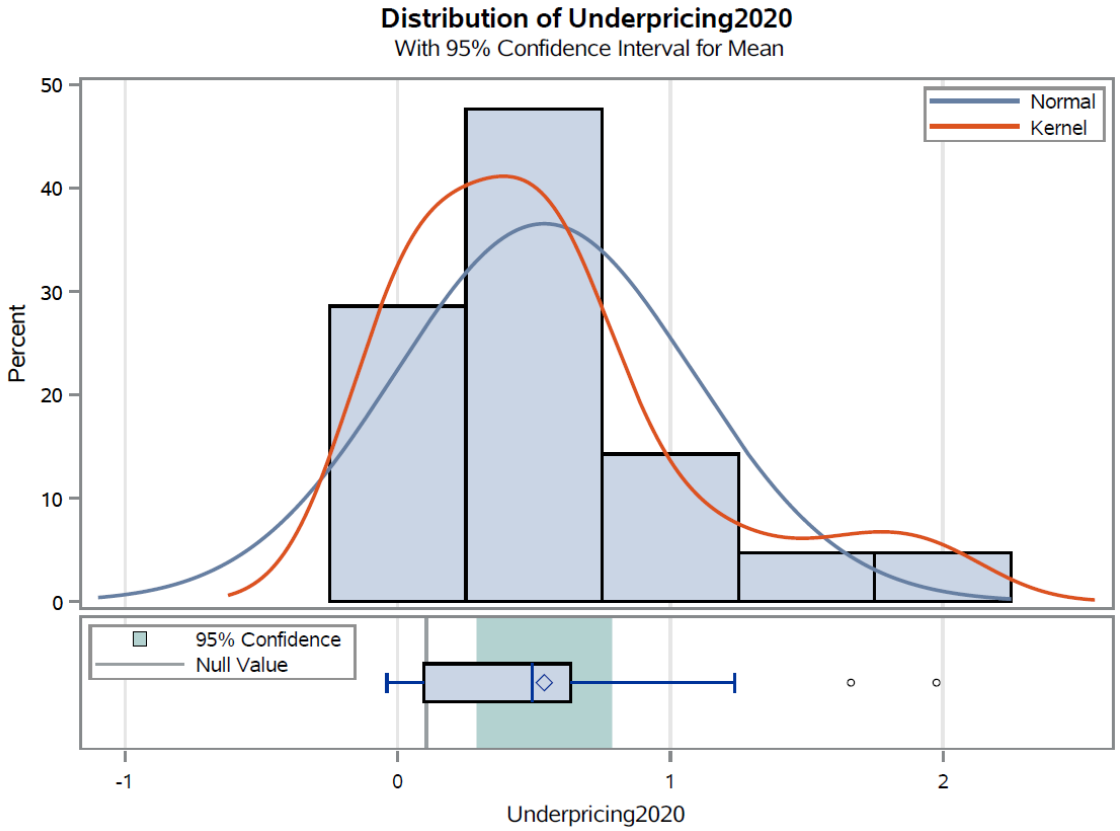


Figure 83 – validity check for the t-test

The necessary condition is that the underpricing distribution must be normally distributed. This condition can be confirmed when the Normal shape and the Kernel shape are close to overlapping. Therefore, in this case, the normal distribution is confirmed from the previous histogram.

I performed the t-test also for the average value in 2018 and 2019 and the result did not change. I just did not post it, for the sake of simplicity.

After having checked the normality assumption validity, I can conclude that in the pandemic year, the underpricing level has not been similar to the previous years.

6.2. Conclusions of the regression analysis

The following is a graphical representation of the results obtained from the regression models presented in the analysis in which are listed only the significant predictors resulting from the analysis. Some predictors are positively related to underpricing and others negatively. Moreover, I used the bubble size to represent the p-value and therefore, how

much a predictor is significant. The bigger the bubble size, the greater the statistical significance.

Note: the regressions were carried out always maintaining α of 5%.

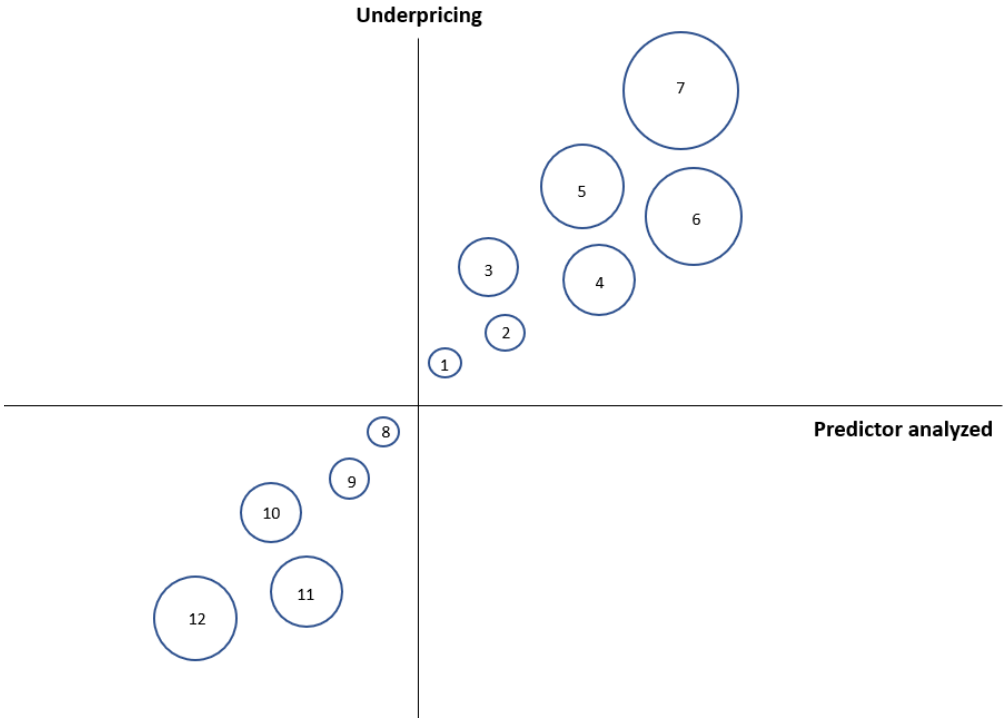


Figure 84 – Graphical representation of underpricing with the predictors analyzed

In the following table there is a legend of the bubbles representing the α of the significant predictors obtained:

BUBBLE NUMBER	PREDICTOR
1	Independent directors
2	Patents owned till the year before the IPO
3	Recent (risky) patents
4	Year 2020
5	Issue size
6	Market capitalization
7	current return less underpricing
8	Quality of the lead underwriter
9	Institutionals
10	Quality of the underwriter syndicate
11	Insider ownership
12	Relative R&D expense

Table 31 – Bubble Legenda

The predictors showing a positive relationship with the underpricing that are significant are listed below and each one is accompanied by an explanation:

- **independent directors**: in Biotechnology IPOs do not seem important to have enough independent directors on the board to reduce the misalignment of interests among managers and shareholders. In fact, as reported in the "Separation of Ownership and Control" of Fama and Jensen talking about traditional IPOs, a high number of independent directors can make the decision-making process slower due to the increased burden of control and auditing causing an increase in the underpricing level (Fama & Jensen, 1983). The statement is confirmed also for Biotechs;
- **Patents the year before the IPO**: a strong result achieved during the analysis is that Biotech is a too risky sector, and therefore, it is not enough for firms willing to get listed to show in the Prospectus a significant number of patents developed until the year before the IPO starts. It does not lead to a reduction in the ex-ante uncertainty around the company leading to a reduction in the underpricing. In fact, the higher the number of patents, the higher the initial returns;
- **Recent risky patents**: the number of patents developed after the average development time has been used as a proxy to understand the patents' quality and consolidation. In fact, the higher the number of patents developed after the average time of a firm, the higher the number of new patents and the risk around the company. Having many recent patents, again, is not used in the Biotech sector, as a way to decrease the ex-ante uncertainty. It, increases the risk around the firm, leading to an increase in the underpricing level;
- **2020**: the dummy year has been used to capture the year-fixed effect. In this chapter, it has been said that during 2020 both the average underpricing and the variability around it increased. 2020 showed a level of underpricing of 0,54. In fact, the year 2020 is significant in the analysis, and therefore, that year shows a higher level of underpricing. A possible explanation of the increased of the risk in 2020 can be due to the high number of a drug approved by FDA following an "**Emergency Use Authorization**" that grants lower quality standards compared to the normal development cycle;

- **Issue size**: the issuing size is strongly related to underpricing. A bigger size leads to a greater underpricing level;
- **Market capitalization**: the same reasoning made for the issuing size applies.
- **Current return except underpricing**: the return net of underpricing has been used as a proxy to capture the risk around the company. Therefore, the higher the risk, the higher the underpricing level. In fact, as stated in the theory, around risky IPOs underwriters try to lower the price to avoid an under subscription of the offering.

The predictors showing a negative relation with the underpricing that are significant are listed below and each one is accompanied by an explanation:

- **Quality of the lead underwriter**: I used the ranking described in the theoretical part of the analysis to test the underwriters' reputation. From what emerged in the analysis, the quality of the lead underwriter is very important for biotech firms wishing to get listed. Therefore, the asymmetric information theory, described in the second chapter "Understanding underpricing theories" is suitable even for biotech companies. Hire a good quality underwriter can lead to a reduction in the asymmetric information and therefore a reduction in the underpricing level;
- **Institutionals**: another theory that is part of the Behavioral theories, called *Information cascade* or *bandwagon effect*, described for traditional IPOs is suitable also for Biotech IPOs. In fact, institutional investors can be used to signal the good quality of an IPO and their presence can attract even uninformed investors, pushing up the demand, and therefore, it is not necessary to lower the offering price by the underwriters. This theory was not proved yet in the literature;
- **Quality of the syndicate**: the sum of underwriters' ranking has been used as a proxy to test the quality of the syndicate. The result obtained is that Biotech firm can use also the good quality of the syndicate to signal that the IPO will be a hot issue. Therefore, choosing with particular attention each underwriter composing the syndicate leads to a lower level of underpricing. For traditional IPOs, Corwin and Schultz in 2005, discovered that a high number of underwriters in the syndicate led to a lower amount of underpricing due to a more precise price-

setting because of the experience of many investment banks. This statement is not true for the biotech sector since, underpricing is influenced by the quality of the syndicate, not by the number of underwriters in it.

- **Insider ownership**: for biotech companies, the presence of insider ownership (shares owned by directors, managers, and employees) can be used to signal the good quality of an IPO and to reassure investors as it happens for traditional IPOs, (Su, 2003). Therefore, a high level of insiders leads to a low level of initial returns;
- **R&D expense**: biotech companies can use the R&D expenditure as a credible sign of commitment, reducing underpricing, as stated in the theoretical part of the thesis work.

In conclusion, as stated in the theoretical part of the work it is common to think that underpricing increases with asymmetric information and that biotech companies are surrounded by intangible assets difficult to be evaluated which leads to asymmetric information that is associated with underpricing. Instead, in the analysis, I found out that, normally the underpricing level of Biotech companies is lower.

The asymmetric theory states that the ex-ante uncertainty around the IPO firm can be reduced by disclosing relevant information to investors in the S1 form. However, Biotechnology is a highly risky industry in which it is not enough to count on several patents. What evinced from the analysis is that Biotech firms, to decrease the uncertainty around the offering must own consolidated patents. In fact, relying only on the number of patents disclosed until the year before the IPO took place is not enough to decrease underpricing. Instead, the more patents developed are mature (developed after the average patent development time) the lower the underpricing level.

Another way to decrease the ex-ante uncertainty is to show in the prospectus a strong R&D commitment. The Biotechnology sector is the only industry that invests in R&D 15% more of what it earns as pointed out in the "2018 EU industrial R&D investment scoreboard", (Hector, et al.). R&D is essential to develop patents and innovative products. In fact, a strong R&D effort is associated with a lower level of underpricing.

Moreover, Biotech firms to decrease the level of underpricing should hire both a good reputation lead underwriter and a good quality syndicate of underwriters. The syndicate is useful in decreasing the risk related to the offering because every underwriter takes charge of only part of the shares to sell and is responsible for that. To generalize, a good reputation

syndicate can be very useful to signal to the market the good quality of the IPO, especially in a highly risky industry.

Another consideration to be made is that, in Biotech IPOs, the presence of insider ownership is a way to reassure investors that the offering is good. This statement again is particularly relevant in a high risky industry.

Moreover, in Biotech IPOs seem not enough to count on independent directors in the BOD to better monitor the management. In fact, the high number of independent directors is associated with a high level of underpricing.

Behavioral theories have not been proved in the literature yet for traditional IPOs and in fact, contrasting evidence is exposed. In the Biotech context, behavioral theories become particularly relevant. In fact, the information cascade or bandwagon effect is confirmed from the regression analysis. The presence of institutions buying shares can signal to uninformed investors the good quality of the IPO influencing them to buy stocks in the offering. In fact, institutional shares are associated with a lower level of initial returns.

As seen before, the year 2020 has been surrounded by a high uncertainty in the market, the underpricing level reached record levels for Biotech IPOs that normally show a level of initial return that is even lower than the one of traditional IPOs making Biotech IPOs even riskier for the issuing firms. In 2020, many Biotech IPOs have been hot issuing, in fact, the demand has been pushed up by the interest of new investors focused on developing innovative drugs and government funding to sustain Biotech firms. In 2020, there has been more than one-hundred IPOs, 50% more compared to the previous year and twenty billions of dollar have been raised, (Cameron & Morrison, 2021).

Bibliography

American Institute of Certified Public Accountants (AICPA). (2013). *Valuation of Privately-Held-Company Equity Securities Issued as Compensation.* New York.

Adam, M. T., Eidels, A., Lux, E., & Teubne, T. (2017, June 22). Bidding Behavior in Dutch Auctions: Insights from a Structured Literature Review. *International Journal of Electronic Commerce*, 363-397. doi:10.1080/10864415.2016.1319222

Adaskou, P. A. (2015). Trade-off-theory vs. Pecking order theory and the determinants of Corporate Leverage: Evidence from a panel data analysis upon French SMEs. *Cogent Economics & Finance*. doi:10.1080/23322039.2015.1006477

Alonso, P., Azofra, V., & Lopez-Iturriaga, F. (2000). Corporate boards in some OECD countries: size, composition, committee structure and effectiveness.

Assobiotec Federchimica & ENEA. (2018). *The Italian Biotech Industry - Facts and Figures.*

Beatty, R. P. (1989). Auditor Reputation and the Pricing of Initial Public Offerings. *The Accounting Review, 64*(4), 693-709. Retrieved November 23, 2020, from www.jstor.org/stable/247856

Begum Erdogan, Rishi Kant, Allen Miller, Kara Sprague. (2016, May). Grow fast or die slow: Why unicorns are staying private. *Mckinsey & Company - Technology, media and telecommunications*.

Berk, J., & DeMarzo, P. (2016). *Corporate Finance.* Pearson.

Booth, B. (2020, September 21). *Evolution Of The Biotech IPO Markets From Busted To Booming*. Retrieved from Forbes: https://www.forbes.com/sites/brucebooth/2020/09/21/evolution-of-the-biotech-ipo-markets-from-busted-to-booming/?sh=7cccb3026ae7

Booth, B. (2020, April 8). *Forbes*. Retrieved from Booming VC-Backed Biopharma: Strong Market Despite Pandemic .

Borsa Italiana. (2009, March 6). *CAPM*. Retrieved from www.borsaitaliana.it: https://www.borsaitaliana.it/notizie/sotto-la-lente/capm.htm

Borsa Italiana. (2020, March 5). *Il metodo DCF - Discounted cash flow*. Retrieved from www.borsaitaliana.it: https://www.borsaitaliana.it/notizie/sotto-la-lente/metodo-dcf-discounted-cash-flow140.htm

Borsa Italiana. (n.d.). *Offerta Pubblica di Sottoscrizione*. Retrieved from www.borsaitaliana.it: https://www.borsaitaliana.it/borsa/glossario/offerta-pubblica-di-sottoscrizione.html

Borsa Italiana. (n.d.). *Offerta pubblica di vendita*. Retrieved from www.borsaitaliana.it: https://www.borsaitaliana.it/borsa/glossario/offerta-pubblica-di-vendita.html

Borsa italiana. (n.d.). *Undepricing*. Retrieved from www.borsaitaliana.it: https://www.borsaitaliana.it/borsa/glossario/underpricing.html

Brau, J. (2012). Why Do Firms Go Public? In D. Cumming, *The Oxford Handbook of Entrepreneurial Finance.* OUP USA. doi:10.1093/oxfordhb/9780195391244.013.0016.

Cameron, T., & Morrison, C. (2021, January 20). 2020 biotech IPOs shatter all the records. *Nature*.

Carter, R., & Manaster, S. (1990). Initial Public Offerings and Underwriter Reputation. *The Journal of Finance, 45*(4), 1045-1067. doi:10.2307/2328714

Che-Yahya, N., Abdul-Rahim, R., & Mohd-Rashid, R. (2017). The Moderating Effect of Information Asymmetry on the Signalling Role of Institutional Investors in the Malaysian IPOs. *Asian Journal of Business and Accounting*.

Corwin, S., & Schultz, P. (2005). The role of IPO underwriting syndicates: pricing, information production and underwriter competition. *Journal of Finance*, 443-486.

Doug, L., & Mark, D. (2005). The rise of venture capital and biotechnology in the US and Europe. *Nature biotechnology, 23*, 672-676. doi:10.1038/nbt0605-672

Duguid, C. (1904). *The Stock Exchange.* London: Routledge. doi:https://doi-org.ezproxy.biblio.polito.it/10.4324/9781315164878

Eisenberg, Sundgren, & Wells. (1998). Larger Board Size and Decreasing Firm Value in Small Firms.

EY. (2020). *When will the economy catch up with the capital markets? Global IPO trends: Q3 2020.*

Fama, & Jensen. (1983). Separation of Ownership and Control.

FDA. (2018, 04 01). *The Drug Development Process*. Retrieved from www.fda.gov: https://www.fda.gov/patients/learn-about-drug-and-device-approvals/drug-development-process

FDA U.S. Food and Drug Administration. (2020, January 31). *21st Century Cures Act*. Retrieved from www.fda.gov: https://www.fda.gov/regulatory-information/selected-amendments-fdc-act/21st-century-cures-act

Gaspar, Massa, & Matos. (2006). Favoritism in Mutual Fund Families? Evidence on Strategic Cross-Fund Subsidization. *The journal of Finance, 61*(1), 73-104.

Ghosh, A. (2002). *Princing and Performance of Initial Public Offerings in the United States.* Paris: Routledge Taylor & Francis Group.

Global Capital. (2019). *Global Capital*. Retrieved from Cornestone investors still key for HK IPOs: https://www.globalcapital.com/article/b1g68np85bzlyd/cornerstone-investors-still-key-for-hk-ipos

Golec, J., & Vernon, J. (2007). Financial Risk in the Biotechnology Industry. *National Bureau of Economic Research*.

Hector, H. G., Nicola, G., Alexander, T., Lesley, P., Petros, G., & Antonio, V. (n.d.). The 2018 EU Industrial R&D Investment Scoreboard. *JRC Publications Repository*. doi:10.2760/131813

Hopkins, M. M., Crane, P. A., Nightingaley, P., & Baden-Fuller, C. (n.d.). Buying big into biotech: scale, financing, and the industrial dynamics of UK biotech, 1980–2009. *Industrial and Corporate Change, 22*(4), 903–952.

Jang, W.-Y. (2007). Media exposure or media hype: evidence from initial public offering stocks in Taiwan. *Journal of Media Economics, 20*(4), 259-87.

Jickling, M. (2007). *CRS Report for Congress - Sarbanes-Oxley and the Competitive Position of U.S. Stock Markets.*

Kallmeyer, V., & Canabou, M. (2001). Risks and Rewards in Biotech Investing. *The Journal of Private Equity, 4*(4), 6-13. Retrieved from www.jstor.org/stable/43503272

LifeSci VC. (2020, March). *LifeSci VC*. Retrieved from Strategic Planning In Biotech During A Pandemic Crisis.

Lin, H. L., Pukthuanthong, K., & Walker, T. J. (2013). An International look at the lawsuit avoidance hypothesis of IPO underpricing. *Journal of Corporate Finance, 19*, 56-77.

Louis K. W. Ying, L. W. (September 1977). Stock Exchange Listings and Secutiries Returns. *The Journal of Financial and Quantitative Analysis*.

MacAvoy, & Millstein. (1999). THE ACTIVE BOARD OF DIRECTORS AND ITS EFFECT ON THE PERFORMANCE OF THE LARGE PUBLICLY TRADED CORPORATION.

Massari, M., Gianfrate, G., & Zanetti, L. (2016). *Corporate Valuation.* New Jersey: John Wiley & Sons.

Migliorati, K., & Vismara, S. (2014). Ranking Underwriters of European IPOs. *European Financial Management, 20*(5), 891-925.

Milne, C.-P., & Kaitin, K.-I. (2010, September 22). Impact of the New US Health-Care-Reform Legislation on the Pharmaceutical Industry: Who are the real winners? *Clinical Pharmacology and Therapeutics, 88*(5), 589-592. doi: https://doi.org/10.1038/clpt.2010.167

Morales, R., & Radoniqi, F. (2018). Intangibles and the Market Value of Biopharmaceutical Startups. *The Journal of Business Inquiry, 18*(2).

Morrison, C. (2018). Fresh from the biotech pipeline-2017. *Nature Biotechnology, 36*(2), 131-136.

Morrison, C., & Lähteenmäki, R. (2017). Public Biotech in 2016 - The Numbers. *Nature Biotechnology, 35*(7), 623-629.

Nachman, D. C., & Noe, T. H. (1994, January). Optimal Design of Securities under Asymmetric Information. *The Review of Financial Studies, 7*(1), 1–44. doi:https://doi.org/10.1093/rfs/7.1.1

New York Times. (2011, May 27). *Why I.P.O.'s Get Underpriced*. (S. D. Solomon, Editor) Retrieved from www.dealbook.nytimes.com: https://dealbook.nytimes.com/2011/05/27/why-i-p-o-s-get-underpriced/

Noguer, B., & Pope, P. (2004). THE DETERMINANTS OF THE GOING PUBLIC DECISION: EVIDENCE FROM THE U.K. Retrieved from https://www.researchgate.net/publication/5134504_THE_DETERMINANTS_OF_THE_GOING_PUBLIC_DECISION_EVIDENCE_FROM_THE_UK

OECD. (2018). *OECD Factbook 2013: Economic, Environmental and Social Statistics.* Paris: OECD Publishing. doi:https://doi.org/10.1787/factbook-2013-en

Pagano, M., Panetta, F., & Zingales, L. (1998). Why Do Companies Go Public? An Empirical Analysis. *The Journal of Finance, 53*(1), 1-3. Retrieved from http://www.jstor.org/stable/117434

Pagano, M., Panetta, F., & Zingales, L. (1998). Why Do Companies Go Public? An Empirical Analysis. *The Journal of Finance, 53*(1), 1-3. Retrieved from http://www.jstor.org/stable/117434

Pagano, M., Panetta, F., & Zingales, L. (1998). Why Do Companies Go Public? An Empirical Analysis. *The Journal of Finance, 53*(1), 16-20. Retrieved from http://www.jstor.org/stable/117434

Quiry, P., Dallocchio, M., Fur, Y. L., & Salvi, A. (2018). *Corporate Finance Theory and Practice* (Fifth ed.). Newark: John Wiley & Sons.

Rashid, Sibdoyal, M. &., Islam, V. K., Rahman, M. S., & Ahsanur. (2019). IPO Underpricing, Regulation, Sentiment and Shariah Screening in Bangladesh. In *Islamic Corporate Finance* (1 ed., Vol. 1). Routledge.

Re-Jin, G., Lev, B., & Zhou, N. (2005, October). The Valuation of Biotech IPOs. *Journal of Accounting, Auditing & Finance, 20*(4), 423–59. doi:https://doi.org/10.1177/0148558X0502000407

Restructuring Charge. (n.d.). Retrieved from Investopedia: https://www.investopedia.com/terms/r/restructuring-charge.asp

Reuters. (2020, June 5). *Virtual certainty bankers ask if success of remote roadshow will last*. Retrieved from https://in.reuters.com: https://in.reuters.com/article/health-coronavirus-banks-roadshows/virtual-certainty-bankers-ask-if-success-of-remote-roadshows-will-last-idINKBN23C0T9

Reuters. (2020, June 3). *Warner Music strikes a chord as shares pop on Nasdaq debut*. Retrieved from www.reuters.com: https://www.reuters.com/article/us-warner-music-ipo-idUSKBN23A1IN

Ritter, J. R. (1984). The "Hot Issue" Market of 1980. *The Journal of Business, 57*(2), 215-240. doi:www.jstor.org/stable/2352736

Ritter, J. R., & Zhang, D. (2007). Affiliated Mutual Funds and the Allocation of Initial Public Offerings. *Journal of Financial Economics , 86*(2), 337-368.

Ritter, J., & Loughran, T. (2004). Why Has IPO UnderpricingChanged Over Time? *Financial Management*, 5 - 37 .

Senior, M. (2020). Europe's Biotech Renaissance. *Nature Biotechnology, 38*(4), 408-415.

Solomon, S. D. (2011). *Why I.P.O.s get underpriced*. Retrieved from www.nytimes.com: https://dealbook.nytimes.com/2011/05/27/why-i-p-o-s-get-underpriced/

Stasior, o., Machinist, B., & Esposito, M. (2018). *Valuing Pharmaceutical assets: when to use NPV vs rNPV.* Retrieved from www.alacrita.comPage 1Valuing Pharmaceutical Assets: When to Use NPV vs rNPV

Strategy& PwC. (2020). *Considering an IPO? The costs of going and being public may surprise you.*

Su, D. (2003). Leverage, insider ownership, and the underpricing of IPOs in China. *International financial markets, institutions & Money*.

The Scientist. (2020, December 1). *opinion: emergency use authorizations are a threat to science*. Retrieved from The Scientist exploring life inspiring innovation: https://www.the-scientist.com/news-opinion/opinion-emergency-use-authorizations-are-a-threat-to-science-68220

Wang, X., & Wan, W. P. (2013). Explaining the Variance in Underpricing among Venture Capital-Backed IPOs: A Comparison Between Private and Corporate VC Firms: Explaining the Variance in Underpricing Among VC-Backed IPOs. *Strategic entrepreneurship journal*, 331-342.

West, R. (1965). New Issue Concessions on Municipal Bonds: A Case of Monopsony Pricing. *Journal of Business, 38*(2), 134-148.

WR Hambrecht + Co. (n.d.). *The OPEN IPO modified Ducth Auction*. Retrieved from https://wrhambrecht.com: https://wrhambrecht.switchboard-live.com/openipo/