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Department of Finance

**Underpriced IPOs in the US: Influence of sectors and VCs in IPOs
performance and price**

André Jorge Vicente Alves

Master in Finance

Supervisor:

Prof. Rui Meireles dos Anjos Alpalhão, Visiting Associate Professor

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Resumo

A subvalorização está presente na maioria das ofertas públicas iniciais, que geralmente têm a tendência de obter um desempenho inferior ao primeiro dia, ao longo do tempo. Tais factos cativaram-me a desenvolver modelos de regressão que permitem avaliar o impacto e a importância que fatores como o preço de oferta, preço de fecho de mercado, subvalorização, tipo de setor, tipo de estrutura de capital e bolsa de valores possuem nas ofertas públicas iniciais em termos de subvalorização, desempenho das ações nos primeiros três anos, entre o terceiro e o quinto ano e ao longo dos cinco anos, bem como o preço da ação no terceiro e quinto ano após a listagem. Para além disto, estes modelos são testados numa amostra composta por ofertas públicas iniciais listadas entre 2000 e 2014. Posto isto, posso afirmar que as ofertas públicas iniciais auxiliadas por capitais de risco têm uma relação positiva com a subvalorização inicial, desempenho e preço das ações no terceiro e quinto ano, enquanto o preço de oferta e o preço de fecho têm com o preço das ações no ano 3 e 5. Os sectores da Tecnologia de Informação, Serviços de Comunicação e Bens não essenciais apresentam uma maior subvalorização que os restantes.

Palavras-chave: IPOs; Underpricing; Venture Capitalist; Sector; Performance; Share Price.

Abstract

Underpricing is present in most of the initial public offerings, which tend to underperform in the course of time. For that reason, I develop regression models that evaluate the impact and importance of factors such as offer price, closing price, underpricing, type of sector, type of capital structure and stock exchange in the initial public offerings first day level of underpricing, 3-year, 3-year to 5-year and 5-year share performance and 3-year and 5-year share price, after the issuance. Furthermore, these models are tested on a sample of initial public offerings listed between 2000 to 2014. Hereupon, I find that venture capitalist backed initial public offerings have a positive relationship with first-day underpricing, 3-year and 5-year performance and share price, whereas the offer price and closing price have with the 3-year and 5-year share price. The Information Technology, Communication Services and Consumer Discretionary sectors underprice more in the first day than the others.

Keywords: IPOs; Underpricing; Venture Capitalist; Sector; Performance; Share Price.

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Introduction

Initial public offerings (IPOs) have been an area of interest for investors and academics since the decade of 1980s. This phenomenon emerges when a private company decides to sell a pre-determined number of its shares to the public, allowing the firm to raise capital from investors, while investors keep a percentage of the business.

IPOs are a common event in stock markets. Generally, companies go public to raise equity capital for the firm and to establish a public market, in order to founders and other shareholders increase their wealth by converting their shares into cash in the future (Ritter and Welch, 2002). Other advantages of floating are the reduction of the cost of capital by the lessening of interest rates on loans and the usage of stock as a currency to acquire other businesses (Brau, 2010). Still, an IPO does not have only advantages and underpricing is an example of it. In fact, according to Loughran, Ritter and Rydqvist (1994); Loughran and Ritter (2004); Rathnayake *et al.* (2019) and others; typically, an IPO is underpriced at the end of the first day of trading. For that reason, this thesis focusses not only in understanding what is the impact of certain factors in underpricing, but also how each type of underpriced IPOs behaves in the long term.

Since literature do not provide many evidences regarding the role of industries in initial public offerings, the objectives of this thesis are to analyze if the type of sector harms or benefits IPOs performance in the long run, its initial underpricing and long-term share price. Furthermore, the presence of venture capitalists is a more studied subject, however I want to perceive if its influence is always positive in every time period, how determinant it is in IPOs' path and if my results are in agreement with the literature.

Besides these variables, I also analyze the role of offer price, closing price and stock exchange in share price and performance, through a data sample of 544 underpriced American IPOs listed in NASDAQ, NYSE and NYSE American between 2000 and 2014. In order to obtain the pretended conclusions, I run several regressions for the initial underpricing, 3-year, 3-year to 5-year and 5-year performance and 3-year and 5-year share price.

Moreover, this thesis is divided by five chapters, the literature review that reports the most relevant studies regarding this area; hypotheses; where I state the research questions I aim to answer; data, where it is possible to find all the sources that provided information and the final sample; the methodology section displays all the formulas and models used to analyze the database and the last chapter presents the analysis of all the results and the evaluation of the hypotheses.

1. Literature Review

Underpricing is a phenomenon widely studied, containing various models and explanations, that have the objective of understanding the situations and reasons in which this event manifests. Throughout this section, the history of underpricing in IPOs across the years in the United States will be approached, the models tested and definitions presented.

Ibbotson and Jaffe (1975) investigated the presence of underpricing in IPOs, and concluded that it only occurred in specific periods of time, while Ritter (1984) supported that it also took place in certain industries. Due to these findings it was proved that initial public offerings were averagely underpriced, in fact, Loughran, Ritter and Rydqvist (1994) found empirical research of 25 countries¹ where companies underpriced averagely at the first day of trading.

In the United States, underpricing reached more than 20% during the 1990s (Ljungqvist, 2007), with some internet firms being the biggest catalyst, since it was possible to observe in these a 50% first-day underpricing. Nevertheless, the average first-day underpricing in developed countries was 15% in the same period (Aggarwal, Krigman and Womack, 2002).

Analyzing, throughout the years, the first-day return on initial public offerings was 7% in the 1980s, between 1999 and 2000 it reached a peak of 65% due to the internet bubble, whereas in the following two years diminished to 12%, on average (Loughran and Ritter, 2004). Among 1980 and 2001, the number of companies going public, in the United States, surpassed one per business day, with some years having less than 100 IPOs, while others possessing more than 400 (Ritter and Welch, 2002).

Furthermore, Rathnayake *et al.* (2019), examined 148 IPOs, in the U.S., from 1991 to 2017, and found that IPOs typically were listing with a price inferior than its closing price at the first-day of trading by 47%.

Not only underpricing exists in primary markets, but it is also present in junior markets, such as the Alternative Investment Market (AIM). These markets fulfill the financial needs of small and young companies that would not fully meet the requirements to be listed in the main markets (Acedo-Ramírez and Ruiz-Cabestre, 2017). Doukas and Hoque (2016), for instance, report that AIM companies that meet Main Market conditions (both markets are based in

¹ These countries were Australia, Belgium, Brazil, Canada, Chile, Finland, France, Germany, Hong Kong, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, New Zealand, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom and United States.

London), exhibit an average underpricing of 19,8%, nearly four times higher than on the Main Market.

Although underpricing is a more analyzed area, first-day overpricing in the United States has also been studied by authors namely Peavy (1990), Chan, Gau and Wang (1992), Ritter and Welch (2002), Purnanandam and Swaminathan (2004), Rathnayake *et al.* (2019) and others.

1.1. Underpricing reasons

There are numerous studies that justify the underpricing which has been examined and discussed by numerous authors throughout the years. Such theories can be divided into four categories, which are: asymmetric information, institutional reasons, control considerations and behavioral approaches (Ljungqvist, 2007).

1.1.1. Asymmetric information

To become a public company, the issuing firm, investors and investment bank are the key parties and the more aligned they are, the more successful the operation tends to be. However, the information that each one holds can be asymmetric when one of the parties has more knowledge than the others. It can occur amongst issuer and underwriter, issuer and investor, investors, and others.

i. Issuer and underwriter

Baron (1982) claimed that in new issues the optimal offer is lower when compared to the best offer price, in order for the issuer to reward the investment banker for the use of its information. Once a firm initiates an IPO, an investment bank is selected to conduct it; bear partially or totally the risk related with the issue and distribute the new shares (Baron and Holmström, 1980). In other words, the firm possesses less expertise regarding the capital markets when compared to the underwriter, with this being the main reason for requiring the service of an investment banker (Baron and Holmström, 1980; Baron, 1982). Consequently, the greater the insecurity the issuer has around the IPO, the higher the cost of the underwriting services becomes (Baron, 1982). Therefore, in situations in which the underwriter is better informed than the issuer, the IPO is underpriced, since “*the issuer has limited information and is unable to determine if the recommended price is appropriate*”, causing an agency problem (Baron and Holmström, 1980:2).

Ritter (1998) also supports in the underwriter monopsony power hypothesis², that investment bankers take advantage of their superior expertise to underprice new issues with the intention of captivating buy-side clients without marketing expenses. Indeed, investment banks underprice their IPOs as well by an identical amount as peer initial public offerings, with the objective of persuading the other parties that underpricing is typical in IPOs. Also, Muscarella and Vetsuypens (1989) concluded that investment banks possess as much underpricing in their IPOs as other issuers, although it is not influenced by the fact the investment bank is leading its IPO. On the contrary, Ljungqvist and Wilhelm (2003) claimed that if underpricing is an agency conflict between issuers and underwriters, occasions in which investment banks are also the issuer, the interests are aligned, and hence the underpricing is inferior.

ii. Issuer and investor

Underpricing can be seen as a signal of a good investment by the investors, once only promising firms can recover the loss caused by the difference of the real value and the value listed. On the other hand, small or low-quality firms prefer to avoid this operation, since they would not recover from the initial loss (Allen and Faulhaber, 1989). Furthermore, the issuer has better information related to the firm's cash flows than the investors. This allows high-quality companies to signal its true value and hence, new shares are issued at a discount in order to compensate investors due to information asymmetry. Besides this, the organization holds part of the shares issued for its personal portfolio (Grinblatt and Hwang, 1989).

This asymmetry impacts differently whether the quality of the company is high or low. Comparing both qualities, corporations with superior attributes can signal their information to investors due to their marginal cost of underpricing, whilst low-quality firms cannot replicate once their marginal cost is higher. In order to mimic high-quality companies, low-quality firms would expend their resources to reproduce the characteristics of high-quality organizations as well as to cover the signaling costs (Welch, 1989).

Therefore, in the signaling model the issuer contains better information regarding his organization, underpricing the IPO in order to signal private data to investors. This operation is only successful with high quality firms.

iii. Informed investors and uninformed investors

² This hypothesis was conceived and tested by Ritter in the article "*The "Hot Issue" Market of 1980*", published in 1984.

Rock (1986) applied the lemons problem (Akerlof, 1970) in his model that includes two types of investors, those who have superior knowledge, which enable them to dismiss overpriced IPOs, buying only shares whose price is below its fair value, and in contrast to these informed investors, uninformed investors who hold limited information and hence have fewer opportunities of getting an allotment in profitable IPOs, since informed investors attempt to drive them away from new firms which they have information and are most likely profitable. As a result, uninformed investors are cursed by getting allotments in overpriced and unattractive IPOs, facing the adverse selection problem.

Thus, when the offer price exceeds the intrinsic value of the share, the uninformed investors receive all the shares requested, experiencing the “winner’s curse”. In opposite situations, the total amount of shares is distributed to informed investors and for that reason, stocks are offered at a discount, with the objective of retaining uninformed investors interested.

For Welch (1989), the winner’s curse could be avoided if underwriters would be willing to offer IPOs exclusively in pools³, withdraw an issue or reward uninformed investors when informed investors’ demand is scarce.

On the contrary, for authors such as Michaely and Shaw (1994) underpricing is implemented in IPOs to seduce uninformed investors, thereby, supporting the “winner’s curse” theory. In initial public offerings in which is known *a priori* that few investors have better information are averagely less underpriced. Though, in IPOs wherein the possession and quantity of knowledge are unknown, the level of underpricing is higher.

Furthermore, these authors attribute underpricing as the reason to exist information asymmetries between investors.

iv. Uncertainty

Uncertainty is correlated with underpricing. In spite the fact that IPOs are on average underpriced, the investor cannot precisely set the value of the company before it begins trading publicly. This occurrence is named *ex ante* uncertainty and the greater it is, the greater the underpricing. Moreover, it is associated with the winner’s curse problem as well, since uncertainty is present when there are few informed investors concerning the value of the firm

³ Pool is the aggregation of financial instruments into the same investment vehicle.

or its performance in the future. For that reason, investors request a higher underpricing to be willing to purchase those shares (Beatty and Ritter, 1986).

v. Bookbuilding

Typically, issuing firms possess more information than the other parties regarding their business. This asymmetry leads issuers to overestimate their company to potential investors (Benveniste and Spindt, 1989).

Besides that, there are two sorts of investor, those who keep good information concerning the listing firm and those who hold erroneous information. Underwriters persuade investors to disclose their information in return for reduced offering prices and future allocations in underpriced IPOs. Thus, underpricing can be used as a compensation for investors who disclose good information when it is not possible to compensate them through an increased share allocation. Also, it is used by underwriters with the objective of investors revealing positive information and it can be reduced when underwriters allocate shares to the same group of clients (Benveniste and Spindt, 1989).

Hanley (1993) agrees with Benveniste and Spindt (1989) in that underpricing is correlated with revisions in the offer price, meaning it only partially adjusts to new information. As a result, issues under a positive offer price revision and good information release are more underpriced than other initial public offerings. Therefore, underwriters and issuing firms prefer to replace underpricing for increased allocations, since leaving money on the table is less valuable to both parties than reducing the size of the owners' residual claims (Hanley, 1993). However, Loughran and Ritter (2000) contradict Hanley's (1993) conclusions, since underwriters do not fully incorporate public information when the offer price is established. Moreover, the Benveniste and Spindt (1989) model is also reviewed, since it does not assume that there should be a partial adjustment related to public information, which is free and hence not necessary to compensate investors for it by leaving money on the table (Loughran and Ritter, 2000).

According to Benveniste and Wilhelm (1990), underwriters can either allocate IPOs to regular investors that reveal good information and compensate them with a lessened winner's curse (with higher costs to the underwriter) or allocate an issue to uninformed investors at a lower cost, however the underwriter faces a larger discount. This model demonstrates that without price discrimination the underwriter has to underprice the issue to all the investors, even those who are uninformed. As a result, more money is left on the table than necessary.

In spite of having a similar theoretical approach to Benveniste and Spindt (1989) and the abovementioned authors, Biais, Bossaerts and Rochet (2002) have a different point of view related to the investment banker, since the authors consider that this side does not operate fully committed with the issuer.

vi. Underwriter

Issuers give more importance in hiring a highly ranked analyst underwriter, regardless the money they normally left on the table. In addition, the issuer is incentivized to choose underwriters with a great underpricing (known as spinning theory⁴), through received payments or preferred shares in IPOs operated by these underwriters (Loughran and Ritter, 2004).

These underwriters underprice initial public offerings for their own benefit. That is, if they are remunerated by the issuer, via underwriting fees, and by the investors who offer quid pro quos for IPO allocations or money left on the table, it is more profitable to advise the issuer with a lower price and receive also the investor's compensation, instead of only the underwriting fees (Nanda and Yun, 1997; Loughran and Ritter, 2002 and 2004). However, by leaving money on the table, underwriters do not profit from quid pro quos in the same amount as the quantity of money left on the table, which leads to consider that investment bankers indirectly benefit more from underpriced IPOs, because issuers do not treat the cost of underpricing and direct costs equally. Hence, underwriters obtain a higher total remuneration than if the compensation was exclusively from direct fees (Loughran and Ritter, 2000).

For these reasons, Ritter and Welch (2002) provide a solution to eliminate asymmetric information by selling initial public offerings in packages.

vii. Investment Bankers

In addition to the abovementioned theories, there are investigations dedicated to the differences among investment banks and the impact of their reputation in shareholders' decisions. Prestigious underwriters are linked with less risky and volatile IPOs, since they cannot risk their reputation with highly underpriced issues. In order to maintain their reputation, the underwriters utilize inaccessible information to select the IPOs with lower risk. Due to their prestige, investors know beforehand that prestigious underwriters' issues have a lower first-day

⁴ The practice of spinning is considered illegal by the Rule 101 of Regulation M under the Securities Exchange Act of 1934 (see: <https://www.lexology.com/library/detail.aspx?g=cda5a130-04bd-4efa-8e20-a3a855b55ba3>), the Rule 10b-5 and section 17 of the 1933 Securities Act, as it is explained in Kennedy's (2003) research.

return, as well as an inferior uncertainty and information asymmetry within investors (Carter and Manaster, 1990).

1.1.2. Institutional reasons

Besides asymmetric information, institutional theories such as litigations, taxes and others are also motive for the existence of underpricing.

The lawsuit hypothesis argues that underpriced IPOs reduce the possibility of a lawsuit and adverse judgments if the lawsuit is filed (Drake and Vetsuypens, 1993). In fact, companies sell stocks at an inferior price with the objective of reducing the probability of future lawsuits due to the underperformance of its shares (Ljungqvist, 2007). For Ritter (1998), underpricing can also be a form of reducing future lawsuits, however it seems to be quite expensive. On the other hand, Drake and Vetsuypens (1993) rejected the lawsuit avoidance hypothesis after testing 93 initial public offerings of sued firms, since these companies were as underpriced as not sued ones. Moreover, Loughran and Ritter (2002) defend that underpricing is an ineffective and expensive strategy to reduce the costs of lawsuits.

When concerning with taxes, managers opt to underprice more or less, since it is possible to have tax benefits related to IPO underpricing (Ljungqvist, 2007).

1.1.3. Behavioral theory

Investors became “irrational” in situations in which stocks are purchased beyond its true value, while issuers suffer from behavioral biases and hence cannot impose themselves towards the underwriter to reduce the underpricing (Ljungqvist, 2007).

i. Bandwagon effect

The bandwagon effect emerges when potential investors of a new issue copy the strategies of other investors besides their own information. That is, an investor decides not to buy shares of a new issue if no other investor is interested, regardless the quality of the information available. In order to avoid this, the issuer underprices the IPO to persuade the first investors to buy, and hence, causing a bandwagon or cascade. This leads to the acquisition of shares from investors who were influenced exclusively by the decision of the initial ones.

In Welch (1992) paper is concluded that later investors replicate the decisions of earlier investors, even if they have contrary information. Consequently, an informational cascade arises, where later investors exploit from that.

1.1.4. Ownership and Control

After the issuing, the ownership and control of the company is diluted with the entrance of new shareholders. According to control theories, underpricing allows the definition of the shareholder core as well as diminish the intervention by outside investors, since the company is public. Furthermore, it has as purposes the retention of control and the reduction of agency costs (Ljungqvist, 2007).

Brennan and Franks (1997) argue that managers may protect their private benefits due to underpricing and reduced monitoring, since their shares are strategically allocated throughout the process of becoming public. Additionally, oversubscription is a result of an underpriced IPO and this enables the issuer to ration the allocation of shares as well as discriminate the applicants. For Booth and Chua (1996) the dispersion of ownership causes a liquid secondary market when the issue is oversubscribed. This leads to a rise in information costs for the investor and therefore a higher equilibrium underpricing.

1.2. Long-term performance

Ibbotson (1975) provided evidence from the 1960s' issues, which allows observing that the first and fourth year after the issuance generated positive return, whereas throughout the second and fourth year these companies underperformed 1% per month averagely.

Amongst the years 1970 and 1990, investors had a 5 percent average return per year, five years following the initial public offering (Loughran and Ritter, 1995). During this period of time, IPO companies underperformed when compared to non-issuing firms, since these had a yearly 12 percent return. Ritter (1998) had similar results, since he studied the performance of IPOs issued among 1970 and 1993, which had an average return of 7,9 percent yearly in the five years subsequently the offering, with the closing price of the first day defined as the purchase price. In order to understand the results of these companies, Ritter (1998) compared them with peer non-issuing firms in terms of market capitalization which performed an average annual return of 13,1 percent. In summary, IPOs had an inferior performance of 5,2 percentual points per year during the five years after the first day of trading as regards to non-issuers.

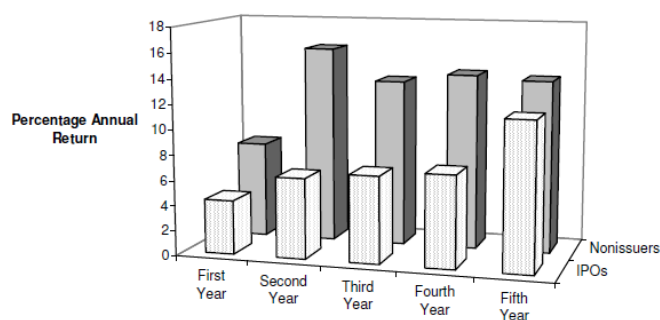


Figure I- Average annual returns of issuing and non-issuing firms for the five years after the offering date (Ritter, 1998).

Ritter and Welch (2002) examined the companies issued from 1980 to 2001 and these underperformed after 3 years by 23,4% in comparison to the Center for Research in Security Prices (CRSP) value-weighted market index and to underperformed seasoned companies with similar market capitalization and book-to-market ratio by 5,1%.

Long-term underperformance is concentrated among young growth companies, particularly the ones issued in the high-volume years of the 1980s. Although this fact does not exclude bad luck being the origin of the underperformance, it aligns with the hypothesis of firms going public when investors are over optimistic regarding the potential of particular industries (Ritter, 1991).

IPOs in which venture capitalists and high-quality investment bankers are not involved also suffer from this phenomenon. Michaely and Shaw (1994) concluded that IPOs issued by more reputable investment banks have better performance in the long term. Indeed, IPOs issued by prestigious underwriters had a 1,5% negative return after two years, while less prestigious underwriters obtained a 26.8% negative return during the same period.

Ritter (1991) pointed over optimism, luck or fads and risk mismeasurement as the causes of IPOs underperformance. Firstly, the expectation, that is, the most optimistic investors regarding an IPO will be the buyers. Over the time, the level of information increases and the opinion of the optimistic and pessimistic converges, declining the market price. Secondly, the market is subject to fads (Aggarwal and Rivoli, 1990; Shiller, 1990) which affect market prices and for that reason, IPOs are underpriced by investment bankers with the purpose of creating a false idea of excessive demand (Ritter, 1998). This predicts low returns in the future in companies with high initial returns (Ritter, 1998). Lastly, the volume of initial public offerings

exhibits large variations over time, meaning that issuers exploit windows of opportunity to launch their businesses in the market with an overvalued evaluation. For companies going public, the cost of external equity capital is lower, as well as the returns in the aftermarket (Ritter, 1991 & 1998).

From the investors point of view, long-run performance of IPOs raises benefits such as the existence of price patterns that enable trading strategies which generate higher returns, and the viability of the informational efficiency of the IPO market due to the existence of non-zero aftermarket performance (Ritter, 1991). Moreover, Ritter and Welch (2002) state that an investor receives 22,6% in returns when he/she buys shares at the first-day of trading and hold them for 3 years. However, the investor would have kept only 83 cents from each dollar replicating this strategy, when compared to investing a dollar in peer companies listed on the American and New York stock exchanges. For this conclusion younger companies are not included, once these had performed worse than average (Ritter, 1991).

Besides the abovementioned causes of IPO underperformance, Brau, Couch and Sutton (2013) analyzed the American IPOs launched from 1985 through 2003 and indicate the acquisition of other businesses as a factor of a worse performance regarding issued firms. Moreover, IPO companies which acquire others within the first year of going public underperform when compared to IPO firms that do not acquire in the same period. The return of the buyer organizations is averagely -15,6% following 3 years and -23,1% over 5 years, whereas non-acquiring IPO companies generate 5,9% and 1,1%, respectively.

Contrarily, Brav and Gompers (1997) claim that IPO underperformance is not an issuing firm consequence or condition, but a small, low book-to-market effect, since non-issuing firms with similar size and book-to-market ratio also have performances below average. Furthermore, non-venture capital backed IPOs which underperform are mostly small size issuers, in other words, with a market capitalization lower than \$50 million.

1.2.1. Venture capitalists

A venture capital (VC) has as objective to finance private companies in early stages of growth. Each venture capital dedicates to certain industries, sizes or regions in order to efficiently detect the most prospect firms and potential investment opportunities which will generate return in the future. Furthermore, they supply advisement or help through their contact network, so that investments can reach its potential (Ritter, 1998).

Jain and Kini (1995) analyzed IPOs with venture capitalists support and non-venture backed IPOs, during the period of 1976 to 1988 and compared post-IPO operating performance using return on assets, cash flows/total assets, sales growth and capital expenditure growth. They found that VC-backed IPOs significantly outperformed in all their measures in a 3-year period after the offering date.

Brav and Gompers (1997) studied 934 venture backed IPOs issued from 1972 to 1992 and 3407 non-venture backed IPOs during 1975 until 1992. After analyzing both samples through equal weighted returns, they concluded that venture backed IPOs outperformed non-venture backed IPOs throughout a five-year period. However, value weighting criteria reduces substantially the differences in performance and consequently lessens the underperformance concerning non-venture backed IPOs. Other explanation given is the concern of the venture capitalists regarding its reputation, since this affects the decisions to make in relation to issuing companies. A venture capitalist has as purpose to bring firms public and it cannot be associated with failures which harm future investments. Hence, venture capitalists may be less willing to hype a stock or overprice it (Gompers, 1996).

Nevertheless, Brav and Gompers (1997) state that markets should reflect the difference of offering price between VC and non-VC backed companies, as well as the similarity of the performance of stock prices in the long-run among these two types of firms.

Michel (2013) examined the return on recent venture capitalist investment and therefore studied 825 American VC backed IPOs between 1991 to 2006, in which higher return venture capital backed IPOs had an inferior performance in comparison to lower return VC backed IPOs by between 32% and 43%, following 3 years after the issuance, on an equal-weighted basis. The methodology was replicated for the 5-year period, with underperformance reaching 48% to 57%. This author pointed three reasons to explain this phenomenon. First of all, the alteration in market conditions and the passage of time, the lack of knowledge to interpret the market or over optimism regarding future market conditions. Secondly, some VCs have the ability to select undervalued companies and through its contacts, experience and money, these firms consequently outperform in the market; or venture capitalists who invested in good quality firms at an early stage sell companies' stock near the IPO date at a high price to other VCs that want to be part of a successful IPO. Lastly, variables such as size, book-to-market liquidity and underwriter rank may impact on the long-run IPO performance.

Regarding firms without venture capital support, Brau and Gompers (1997) concluded that large non-venture backed IPOs outperform smaller non-venture backed firms.

2. Hypotheses

The objective of this thesis is to analyze the long-term performance of American underpriced (at the end of the first day of trading) IPOs after 3 and 5 years and understand if they are affected by certain variables such as the type of industry, level of underpricing and presence of venture capitalists. Moreover, I want to verify if the conclusion related with the performance of IPOs from different industries are going to be consistent with the results obtained by Ibbotson (1975), Ritter (1991), Loughran and Ritter (1995), Ritter (1998) or Ritter and Welch (2002) although they did not categorize the IPOs per industry; and the importance of venture capitalists in the long-term and compare it to Jain and Kini's (1995), Brav and Gompers' (1997) and Michel's (2013) conclusions.

Gandolfi *et al.* (2017) studied the underpricing and the performance of IPOs per industry in Italian, French and German markets over the year 1 and year 3. Their objective was to analyze whether industry is a determinant of underpricing and long-run performance, which they concluded in their investigation that it does not affect underpricing and performance in the three European countries.

This study aims to answer some research questions such as: *“Is there a relationship between the level of underpricing and industry?”*, *“Is the type of industry a key factor in long-run performance? If it is, what industry impacts the most?”*, *“Does the presence or success of VC-backed IPOs vary from industry?”*, *“Do venture capitalists play a crucial role in the long-run performance?”*, *“Is there a difference of results between VC-backed IPOs and non-VC-backed IPOs according to the industry? And the outcome of this comparison relies on the type of industry?”*, *“Do companies perform worse in the long term due to high underpricing in the initial public offering?”*.

In order to answer to these questions, I need to formulate hypotheses, establish relationships between variables and test them to observe the behaviour of long-run performance of underpriced IPOs and consequently, outline the best scenario which allows the maximization of its performance in the long-term.

Therefore, this study consists on the following hypotheses:

Hypothesis 1: *There is a relationship between the type of sector and level of underpricing.* E.g., The IPO firms from sector A are more underpriced than the IPOs of other sectors at the first day of trading.

Hypothesis 2: *There is a relationship between the type of sector and long-run performance.* E.g., Only the IPOs from sector A underperformed in the long-term when compared to the remaining sectors.

Hypothesis 3: *The presence of venture-capitalists is correlated with the type of sector.* The objective of this hypothesis is to understand whether VCs are more concentrated in a certain sector and if there is a reason or it is random.

Hypothesis 4: *The presence of VCs in IPOs affects its performance in the long-term.* I.e., I want to verify if the results are going to be similar from the abovementioned authors (VC backed IPOs outperformed non-VC backed IPOs), even though the sample period is different.

Hypothesis 5: *The performance of VC-backed IPOs depends on the sector where they are involved.* This hypothesis is different than the H3, since it aims to answer if the performance of VC-backed IPOs is influenced by the sector or only due to the value that VCs provide to their businesses.

Hypothesis 6: *The performance of not-VC-backed IPOs depends on the sector where they are involved.* I want to test for not VC-backed IPOs the same hypothesis as H5.

Hypothesis 7: *Companies with high underpriced IPOs perform worse in the long-run.* Through this hypothesis, I can perceive if the level of underpricing affects performance positively or negatively, in the long-term as well as the existence of a relationship between the two variables.

In the further sections, I exhibit the data sample, as well as the methodologies applied to test the hypotheses and reach the necessary conclusions to answer to the research questions.

3. Data

The study uses an initial sample of 555 IPOs listed from 2000 to 2014 in New York Stock Exchange (NYSE), NASDAQ and New York Stock Exchange American (NYSE American), which is the former American Stock Exchange (AMEX). In order to reach to all the information required to test the hypotheses abovementioned, I searched for the offer price, first day closing price, stock exchange, industry, presence of venture capitalists, 3-year share price, 5-year share price and status maker of each IPO.

This sample includes companies from various sectors, which are classified through an industry taxonomy named Global Industry Classification Standard (GICS). This system divides the market into 11 sectors which are:

- Energy;
- Materials, which contains, the metals, paper products, construction materials and chemicals industries;
- Industrials, that is divided by the transportation, commercial & professional services and capital goods industry groups;
- Consumer Discretionary, that englobes retailing, consumer services & durables and automobiles & components;
- Consumer Staples, that is mainly focused in food and household & personal products;
- Health Care, which contains as its name implies, health care services, pharmaceuticals and biotechnology industry groups;
- Financials, which includes banks, diversified financials and insurance;
- Information Technology, where software and technology industry groups are inserted;
- Communication Services, that is dedicated to media, communication and entertainment areas;
- Utilities, which is composed by water, gas, electricity and other utilities;
- Real Estate.

The data collection of the variables needed remains a challenge, since there is limited public information regarding IPOs and entities which hold relevant information only makes it available for a given monetary value that solely corporate bodies may afford. Nevertheless, the

data that I use in this thesis comes from different sources, once the variables that I demanded were not combined in a unique database.

The target aimed were underpriced IPOs from active companies listed in NYSE, NASDAQ and/or NYSE American with its industry designation. To obtain the underpriced IPOs, I used the database from the independent news and research firm IPOscoop.com which provides 2520 IPOs, from May 2000 to 2014, with the company name, ticker symbol, offer price, opening price and first day closing price. As for the remaining variables I accessed the data research website Wharton Research Data Services (WRDS) from the University of Pennsylvania, which contains several databases from different informational companies and vendors. Through WRDS, I utilized the Compustat North America database from where I extracted 3041 IPOs from 2000 to 2014 with the company name, ticker symbol, stock exchange, status of the company (if it is active or inactive) and industry.

After reuniting all the information into a single file, I merged both databases by its ticker symbol in order to match the common companies and have all the variables needed to proceed to the next selection phase. Firstly, I eliminated all the initial public offerings that had a first day closing price inferior than its offer price, and hence, the sample came up with 1710 IPOs instead of the initial 2520. To comply with the defined criteria, subsidiaries; companies that are publicly traded but operate in over-the-counter (OTC) markets or in other major stock exchange except NYSE, NASDAQ or NYSE American; firms that have undergone a leverage buyout; reached bankruptcy; were acquired; merged; delisted; and became inactive between 2000 to 2019 were not accounted in the final sample.

From the 1710 IPOs, 588 companies were inactive, 31 belonged to other stock exchanges or were subsidiaries and 12 merged or got acquired. Moreover, 524 companies did not have a match in all the variables and for that reason they were also excluded.

In table I we can observe how the final sample is structured by year and industry.

Year	Number of IPOs	Energy	Materials	Industrials	Consumer Discretionary	Cons. Staples	Health Care	Financials	Info. Tech.	Communication Services	Utilities	Real Estate
2000	31	1	0	5	1	0	9	0	10	4	0	1
2001	6	2	1	0	1	0	2	0	0	0	0	0
2002	5	0	0	0	3	0	0	0	1	1	0	0
2003	12	1	1	0	5	0	1	4	0	0	0	0
2004	33	1	1	6	5	0	6	6	4	3	1	0
2005	28	3	2	6	3	0	4	3	2	3	0	2
2006	48	3	4	15	7	0	3	5	9	1	0	1
2007	49	8	0	7	7	0	5	6	9	5	1	1
2008	6	1	1	3	0	0	0	0	1	0	0	0
2009	15	0	1	4	2	0	2	0	3	2	0	1
2010	38	3	1	4	5	1	3	4	13	1	0	3
2011	33	5	1	4	5	2	4	1	7	3	0	1
2012	53	8	0	8	5	1	6	7	13	3	0	2
2013	84	5	3	4	12	1	26	9	11	6	1	6
2014	114	9	3	5	18	1	39	10	18	5	2	4
2000-2014	555	50	19	71	79	6	110	55	101	37	5	22

Table I- Number of IPOs per year and per industry.

The initial public offerings from the Consumer Staples and Utilities sectors were excluded from the sample, since the size of these two areas is not statistically significant in order to perform a reliable a test. Therefore, in Figure II is represented the weight of each sector in the final sample:

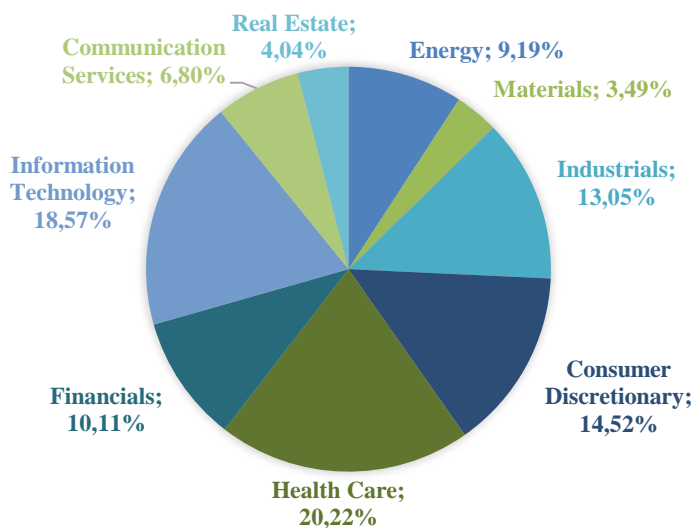


Figure II – Representation of each sector in percentage.

As we can observe, the Health Care (20,22%), Information Technology (18,57%) and Consumer Discretionary (14,52%) sectors represent more than half of the sample. Comparing

to the 3041 IPOs listed between 2000 and 2014 that Compustat provides, Information Technology had the most IPOs listed (22,78%), Health Care (20,49%) was the second sector with more issues, while the Consumer Discretionary was the fourth with 10,01%. This means that more than half of the firms that listed in the market, operate in these areas, especially in the first two.

After the sample was settled, I accessed the EIKON Datastream database, with the objective of getting the IPOs which were supported by a venture capital between 2000 and 2014. Thus, I used the Private Equity Screener, a program inside this database, which provides venture capital investments within the private equity universe.

The process of identifying VC-backed IPOs was the most complex to accomplish, since the availability of this information is scarce, because private companies are not obliged to disclose these types of event to the public. The details regarding the structure of the company are accessible in the prospectus when the firm intends to go public, however reading the prospectus of each company of the sample was not a feasible solution.

Although Private Equity Screener does not possess the VC-backed IPOs during 2000 to 2014, it displays all the private companies which made deals with venture capitalists between 1990 and 2014. Consequently, I looked for the firms of our sample in this database with the purpose of finding the ones which sold part of their business to a venture capital while they were private.

Following this process, the outcome was 299 VC-backed IPOs and 245 not VC-backed IPOs, excluding the Utilities and Consumer Staples sectors. In table II it is shown in detail the presence of venture capitalists in each industry per year and in total, and the weight that it also represents, respectively.

Year	Number of IPOs	VC-backed		Energy		Materials		Industrials		Consumer Discretionary	
		No.	%	VC-backed	%VC-backed	VC-backed	%VC-backed	VC-backed	%VC-backed	VC-backed	%VC-backed
2000	31	17	54,84%	0	0,00%	0	0,00%	4	80,00%	0	0,00%
2001	6	1	16,67%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
2002	5	2	40,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
2003	12	4	33,33%	0	0,00%	0	0,00%	0	0,00%	2	40,00%
2004	32	17	53,13%	0	0,00%	0	0,00%	3	50,00%	2	40,00%
2005	28	10	35,71%	1	33,33%	1	50,00%	1	16,67%	0	0,00%
2006	48	17	35,42%	0	0,00%	1	25,00%	1	6,67%	4	57,14%
2007	48	27	56,25%	2	25,00%	0	0,00%	4	57,14%	6	85,71%
2008	6	3	50,00%	0	0,00%	0	0,00%	2	66,67%	0	0,00%
2009	15	10	66,67%	0	0,00%	0	0,00%	2	50,00%	2	100,00%
2010	37	24	64,86%	1	33,33%	1	100,00%	1	25,00%	2	40,00%
2011	31	21	67,74%	2	40,00%	0	0,00%	2	50,00%	3	60,00%
2012	52	30	57,69%	2	25,00%	0	0,00%	5	62,50%	1	20,00%
2013	82	44	53,66%	0	0,00%	2	66,67%	2	50,00%	1	8,33%
2014	111	72	64,86%	1	11,11%	0	0,00%	1	20,00%	8	44,44%
2000-2014	544	299	54,96%	9	18,00%	5	26,32%	28	39,44%	31	39,24%

Health Care		Financials		Information Technology		Communication Services		Real Estate	
VC-backed	%VC-backed	VC-backed	%VC-backed	VC-backed	%VC-backed	VC-backed	%VC-backed	VC-backed	%VC-backed
9	100,00%	0	0,00%	3	30,00%	0	0,00%	1	100,00%
1	50,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
0	0,00%	0	0,00%	1	100,00%	1	100,00%	0	0,00%
0	0,00%	2	50,00%	0	0,00%	0	0,00%	0	0,00%
5	83,33%	2	33,33%	3	75,00%	2	66,67%	0	0,00%
2	50,00%	2	66,67%	1	50,00%	2	66,67%	0	0,00%
3	100,00%	1	20,00%	6	66,67%	1	100,00%	0	0,00%
3	60,00%	1	16,67%	7	77,78%	4	80,00%	0	0,00%
0	0,00%	0	0,00%	1	100,00%	0	0,00%	0	0,00%
1	50,00%	0	0,00%	3	100,00%	2	100,00%	0	0,00%
3	100,00%	3	75,00%	12	92,31%	1	100,00%	0	0,00%
4	100,00%	1	100,00%	7	100,00%	2	66,67%	0	0,00%
5	83,33%	2	28,57%	12	92,31%	3	100,00%	0	0,00%
23	88,46%	2	22,22%	8	72,73%	5	83,33%	1	16,67%
34	87,18%	5	50,00%	16	88,89%	5	100,00%	2	50,00%
93	84,55%	21	38,18%	80	79,21%	28	75,68%	4	18,18%

Table II – Presence of venture capitalists per sector and per year.

As it is possible to observe, Health Care (84,55%), Information Technology (79,21%) and Communication Services (75,68%) are the sectors with more VC support. On the other hand, only 18% of the Energy and Real Estate IPOs are VC-backed.

Lastly, I obtained the 3-year and 5-year share price subsequently the issue through Compustat North America daily prices, that enables the user to search for the specific companies he/she demands.

Since this thesis focus on IPOs' long performance, the initial public offerings had to be listed long enough in order to its daily share prices were available throughout the five years following the issuance. For that reason, the range period of the sample is amid 2000 and 2014. Furthermore, I used the same day as the issue for the third and fifth-year share price to have the most accurate value possible. In the years in which the day was on a holiday or at a weekend, three days were added, applying the price of that date. In other terms, if a company was issued on the 5th of December 2005 and in 2008 this day was on a Saturday, I used the 8th December 2008 for the 3-year share price.

As Compustat North America did not possess the daily prices of all the companies of our database, I accessed Yahoo Finance and ADVF to fill the missing values.

In Table III it is displayed the average share price of the IPOs in the long term for every industry, as well as the average underpricing (%).

	Offer Price	Opening Price	Closing Price	Underpricing (%)	3-y Share Price	5-y Share Price
All Industries	\$15,908	\$19,207	\$19,769	23,693%	\$24,702	\$29,646
Energy	\$18,796	\$20,756	\$20,966	10,342%	\$22,295	\$22,556
Materials	\$16,972	\$19,011	\$19,623	13,448%	\$30,741	\$30,965
Industrials	\$15,125	\$17,192	\$17,827	18,384%	\$21,837	\$23,223
Consumer Discret.	\$17,258	\$22,183	\$23,164	33,506%	\$27,683	\$35,447
Health Care	\$12,755	\$15,733	\$16,462	25,849%	\$19,477	\$23,940
Financials	\$18,284	\$20,769	\$21,105	15,520%	\$23,946	\$24,837
Information Tech.	\$15,450	\$20,219	\$20,765	31,088%	\$30,626	\$42,365
Comm. Services	\$16,838	\$21,020	\$21,143	32,427%	\$26,609	\$30,213
Real Estate	\$16,477	\$17,427	\$17,572	5,803%	\$21,097	\$25,730

Table III – IPOs average prices and average level of underpricing per sector.

In terms of underpricing, four sectors surpassed the average market sample, which were Health Care (25,849%), Information Technology (31,088%), Communication Services (32,427%) and Consumer Discretionary (33,506%). Furthermore, only Industrials, Health Care and Information Technology had an offer price below the market sample, whereas Energy's \$18,796 a share was the highest offer price among all sectors.

Regarding long-term share prices, Information Technology had the highest price of \$30,626 and \$42,365 per share, averagely, over 3 and 5 years the issue, respectively. Besides this,

Materials, Consumer Discretionary and Communication Services sectors also had a share price above the market sample, while Health Care and Energy registered the smallest 3-year and 5-year share price.

Dividing the sample into VC-backed IPOs and non-VC-backed IPOs, it is possible to observe in Table IV that initial public offerings with the presence of venture capitalists presented a higher underpricing. In fact, averagely, every industry except the Energy sector, had a higher level of underpricing when the IPO was VC-backed.

	Offer Price	Opening Price	Closing Price	Underpricing (%)	3-y Share Price	5-y Share Price
VC-backed	\$15,061	\$19,031	\$19,672	29,314%	\$26,589	\$33,697
Non-VC-backed	\$16,942	\$19,421	\$19,889	16,834%	\$22,398	\$24,703
Energy VC-backed	\$16,611	\$17,423	\$17,561	5,761%	\$19,908	\$21,783
Energy non-VC-backed	\$19,275	\$21,488	\$21,714	11,347%	\$22,820	\$22,726
Materials VC-backed	\$14,656	\$15,958	\$16,736	15,460%	\$32,464	\$25,648
Materials non-VC backed	\$17,799	\$20,101	\$20,654	12,730%	\$30,126	\$32,864
Industrials VC-backed	\$13,554	\$15,521	\$17,223	26,766%	\$22,994	\$23,489
Industrials non-VC-backed	\$16,148	\$18,279	\$18,221	12,296%	\$21,083	\$23,050
Cons. Discret. VC-backed	\$18,649	\$24,848	\$25,663	38,850%	\$35,067	\$49,101
Cons. Disc. non-VC-backed	\$16,359	\$20,462	\$21,551	30,055%	\$22,915	\$26,630
Health Care VC-backed	\$12,669	\$15,792	\$16,561	26,635%	\$20,105	\$24,676
Health Care non-VC-backed	\$13,221	\$15,411	\$15,918	21,552%	\$16,043	\$19,914
Financials VC-backed	\$18,128	\$21,762	\$22,086	22,950%	\$29,395	\$29,800
Financials non-VC-backed	\$18,380	\$20,156	\$20,498	10,931%	\$20,581	\$21,771
Info. Tech. VC-backed	\$15,431	\$20,651	\$21,140	33,028%	\$30,951	\$44,287
Info. Tech. non-VC-backed	\$15,524	\$18,573	\$19,336	23,694%	\$29,389	\$35,044
Comm. Services VC-backed	\$16,389	\$21,245	\$21,062	37,296%	\$29,381	\$35,525
Comm. Serv. non-VC-backed	\$18,232	\$20,322	\$21,396	17,279%	\$17,987	\$13,684
Real Estate VC-backed	\$17,625	\$19,000	\$19,349	9,115%	\$22,982	\$28,238
Real Estate non-VC-backed	\$16,222	\$17,077	\$17,177	5,067%	\$20,678	\$25,173

Table IV – Sectors' average price and average level of underpricing in the presence of venture capitalists.

Contrarily, non-VC-backed IPOs had higher offer prices, on average, than companies issued with the support of venture capitalists in every sector, except in Consumer Discretionary and Real Estate. The same result was not replicated in the 3-year and 5-year share price, since non-VC-backed IPOs only outperformed VC-backed companies in the sectors of Energy, in both years, and Materials, in year 5.

Only Communication Services and Energy non-VC-backed IPOs had a decrease in its share price, during the 5-year period of analysis.

4. Methodology and Results

This chapter exhibits all the methods and formulas that I will apply, with the purpose of discovering the influence of variables such as type of sector and venture capitalist support on the initial public offerings, the reasons for existing different underpricing levels among sectors, as well as finding the major causes and variables that affect IPOs long-term performance.

4.1. Underpricing

The first step was to compute the first day level of underpricing (%) for each sector as it is shown in the tables III and IV of the previous section. The offer price and the first day closing price were the variables utilized, since the difference of these, result in the underpricing as the following formula demonstrates:

$$U = \left(\frac{P_{i1} - P_{i0}}{P_{i0}} \right) * 100 \quad (1)$$

With P_{i0} as the offer price of the issue i and P_{i1} the first day closing price of the same IPO. After computing it for each company, I used the mean function in order to have an average underpricing value for every restriction. Moreover, all the outcomes are presented in average terms.

4.2. Annual growth rate

To evaluate the performance of each company, I computed the average annual growth rate for the first 3 years, five years and between the year 3 and year 5. As a result, it is possible to observe the evolution of the share price, from the first day of trading to the fifth year, through the comparison of the level of underpricing with the average annual growth, which is obtained as follows:

$$G_{i,j} = \left[\left(\frac{P_{j,k}}{P_{i,k}} \right)^{\frac{1}{j-i}} \right] - 1 \quad (2)$$

With $P_{j,k}$ as the j -year share price P of the company k and $P_{i,k}$ the i -year share price P of the same company (k). Moreover, the j and i letters take values of 0 as the offer price, 3 as the 3-year share price and 5 as 5-year share price. Therefore, this formula provides the average annual growth rate G between the year i until the year j , with the last value being always greater than

the first one. Lastly, I computed the average growth of each sector through the results of every company.

In Table V, I compare the average underpricing and the average annual growth industry.

	Underpricing (%)	3-y Growth	3y-5y Growth	5-y Growth
All Industries	23,693%	7,518%	9,476%	4,974%
Energy	10,342%	-1,394%	5,563%	-2,087%
Materials	13,448%	10,754%	9,907%	6,386%
Industrials	18,384%	6,494%	4,830%	3,142%
Consumer Discret.	33,506%	7,973%	10,018%	5,233%
Health Care	25,849%	4,923%	12,492%	3,179%
Financials	15,520%	6,062%	3,327%	2,583%
Information Tech.	31,088%	14,443%	14,213%	11,795%
Comm. Services	32,427%	9,730%	9,208%	5,395%
Real Estate	5,803%	7,739%	10,050%	7,700%

Table V – Sectors' share performance after three years, five years and between the third and fifth year.

Despite the increase in the 3-year and 5-year share price showed in table III, the IPOs long-term performance was significantly lower when compared to the first day. In fact, only Real Estate had a higher growth rate in all periods analyzed, compared with the first day of trading. Nevertheless, the industries inside Materials, Consumer Discretionary, Information Technology, Communication Services and Real Estate overperformed the market sample in the first three years and during the five years subsequently to the issue.

Regarding the average annual share price growth, the Information Technology registered the highest growth from the issue day to the third year with 14,443% per year, while Energy was the only sector which performed negatively, with an average price decrease of 1,394% yearly. Between the third and fifth year, the Information Technology sector stood out with 14,213% annual growth, whereas the Financial sector only grew 3,327% per year. Indeed, all industries had a positive growth, with the Materials, Consumer Discretionary, Health Care, Information Technology and Real Estate as the sectors which performed above the market sample.

Throughout the period of analysis, the Information Technology and Energy IPOs were the most and less profitable areas with 11,795% and -2,087% yearly, respectively, despite Energy's growing tendency in the last two years of the study. Even though this sector had generated, averagely, a higher share price than the offer price, its growth was negative, since the majority of its firms had a decrease in its price. Actually, the 3-year growth and 5-year growth had a median of -6,642% and 0,013%, which means that in the first period of analysis more than half

of the companies lost value, while in the second period approximately half of the companies continued to lose, however this drop was higher, since the growth rate decreased even more.

After analyzing the sectors' share price growth for the different time periods, I replicated the same process to obtain the share price performance per industry in the presence of venture capitalists. Thus, it is displayed in Table VI the behaviour of VC-backed and non-VC-backed IPOs throughout the years.

	Underpricing (%)	3-y Growth	3y-5y Growth	5-y Growth
VC-backed	29,314%	10,429%	10,750%	7,230%
Non-VC-backed	16,834%	3,965%	7,921%	2,219%
Energy VC-backed	5,761%	-0,512%	-2,123%	-3,515%
Energy non-VC-backed	11,347%	-1,587%	7,251%	-1,774%
Materials VC-backed	15,460%	-10,019%	14,549%	-8,392%
Materials non-VC backed	12,730%	18,173%	8,249%	11,663%
Industrials VC-backed	26,766%	9,804%	2,025%	4,431%
Industrials non-VC-backed	12,296%	4,339%	6,656%	2,303%
Cons. Discret. VC-backed	38,850%	14,808%	6,753%	9,259%
Cons. Disc. non-VC-backed	30,055%	3,559%	12,126%	2,632%
Health Care VC-backed	26,635%	5,403%	12,414%	3,219%
Health Care non-VC-backed	21,552%	2,298%	12,917%	2,961%
Financials VC-backed	22,950%	11,324%	3,824%	5,964%
Financials non-VC-backed	10,931%	2,812%	3,021%	0,495%
Info. Tech. VC-backed	33,028%	15,635%	16,494%	13,727%
Info. Tech. non-VC-backed	23,694%	9,901%	5,525%	4,437%
Comm. Services VC-backed	37,296%	15,055%	10,289%	9,590%
Comm. Serv. non-VC-backed	17,279%	-6,835%	5,848%	-7,654%
Real Estate VC-backed	9,115%	6,702%	13,078%	8,262%
Real Estate non-VC-backed	5,067%	7,969%	9,377%	7,575%

Table VI – VC and non-VC-backed IPOs share performance after three years, five years and between the third and fifth year per sector.

As well as in Table V, both structures of IPOs did not maintain the performance levels verified at the end of the first day, despite the growth increase between year 3 and year 5. Notwithstanding, VC-backed IPOs outperformed, on average, in the three periods analyzed.

Actually, in the first three years after the issuance, the average growth rate of VC-backed IPOs was higher in all sectors except Materials and Real Estate, although the best result came from Materials non-VC-backed IPOs (18,173%). The worst was also registered in this sector by IPOs with venture capital support (-10,019%). It may be surprising that the variable which presented the second highest share price (\$32,464) had a price decrease of 10% per year. This has an explanation, since the price rise was due to a firm which noted a growth of 105,5% yearly, reaching \$138 per share in the third year, far above the average Materials VC-backed

IPOs' offer price. Moreover, this had a tremendous impact, since the variable size is 5 companies.

Evaluating the average annual returns between year 3 and year 5, only the Energy VC-backed IPOs lost value, while more than half of the variables performed better in these last two years of analysis than in the first three. Within these variables, non-VC-backed IPOs had a higher improvement than VC-backed IPOs in six sectors, such as Energy, Industrials, Consumer Discretionary, Health Care, Financials and Communication Services.

In this last-mentioned variable, its average share price grew from the third to the fifth year due to two firms that recovered and had 70% and 97% growth yearly, however the Communication Services non-VC-backed IPOs price continued to be below the offer price. The Materials VC-backed initial public offerings also had an improvement during this period, however it was in a different scenario, since these companies continued to lose value, but with a smaller decrease, which originated a positive growth in the share price.

Regarding the five years subsequent to the issue, the Information Technology VC-backed IPOs had the best performance (13,727%), whilst companies from the Energy sector had averagely decreased its price every year by 3,515%. In fact, only the Energy sector, Materials VC-backed IPOs and Communication Services non-VC-backed IPOs had negative outcomes during this period.

4.3. Relative price variation

After analyzing the performance per industry sectors and VC and not-VC-backed initial public offerings throughout five years, I computed the share price difference between every sector and the market sample, in order to observe whether sectors outperformed or underperformed the market price for each moment of time. Therefore, this formula is expressed as follows:

$$V_{j,i} = P_{j,i} - P_{M,i} \quad (3)$$

Where $V_{j,i}$ represents the variation of the sector j in year i and it is obtained through the difference between the average share price P of the sector j in year i and the average share price of the market P_M . The letter i assumes the value 0 for the first day underpricing, 3 for the 3-year share price and 5 for the 5-year share price.

The next tables display the share price variation per sector and per capital structure.

	Offer Price	Closing Price	Underpricing (%)	3-y Share Price	5-y Share Price	O.Price Variation	C.Price Variation	Und. Variation	3y S.P. Variation	5y S.P. Variation
All Industries	\$15,908	\$19,769	23,693%	\$24,702	\$29,646	-	-	-	-	-
Energy	\$18,796	\$20,966	10,342%	\$22,295	\$22,556	\$2,888	\$1,197	-13,351%	-\$2,407	-\$7,090
Materials	\$16,972	\$19,623	13,448%	\$30,741	\$30,965	\$1,064	-\$0,146	-10,245%	\$6,039	\$1,319
Industrials	\$15,125	\$17,827	18,384%	\$21,837	\$23,223	-\$0,783	-\$1,942	-5,309%	-\$2,865	-\$6,423
Consumer Discret.	\$17,258	\$23,164	33,506%	\$27,683	\$35,447	\$1,350	\$3,395	9,813%	\$2,981	\$5,801
Health Care	\$12,755	\$16,462	25,849%	\$19,477	\$23,940	-\$3,153	-\$3,307	2,156%	-\$5,225	-\$5,706
Financials	\$18,284	\$21,105	15,520%	\$23,946	\$24,837	\$2,376	\$1,336	-8,173%	-\$0,756	-\$4,809
Information Tech.	\$15,450	\$20,765	31,088%	\$30,626	\$42,365	-\$0,458	\$0,996	7,395%	\$5,924	\$12,719
Comm. Services	\$16,838	\$21,143	32,427%	\$26,609	\$30,213	\$0,930	\$1,374	8,734%	\$1,907	\$0,567
Real Estate	\$16,477	\$17,572	5,803%	\$21,097	\$25,730	\$0,569	-\$2,197	-17,890%	-\$3,605	-\$3,916

Table VII – Share price variation per sector.

As one can observe, Materials, Industrials, Health Care and Real Estate sectors had a smaller closing price than the market sample and an inferior level of underpricing as well, except Health Care that managed to underprice 2,156% more. Besides these variables, Energy, Financials and Real Estate also have lower results compared to all industries.

In contrast, Consumer Discretionary, Communication Services and Information Technology beat the market for every time period. It should also be noted that the Materials sector was only surpassed by the market at the end of the first day.

Regarding long-term share price, the industries within Energy, Industrials, Health Care, Financials and Real Estate failed to keep up with the average market prices. In fact, these sectors registered a bigger gap in year 5 than in year 3. Moreover, only two sectors had a positive increased variation, since the first day until the fifth year, which are Information Technology and Consumer Discretionary. Although the Communication Services had demonstrated a higher price than the market, this difference decreased from year 3 to year 5.

In summary, Information Technology was the sector with the greatest difference of price compared to all industries, though it has had an offer price below the average.

After this, table VIII presents the variation in price of VC-backed IPOs per sector with the VC-backed average market price, along with price difference of non-VC-backed IPOs from a particular sector and non-VC-backed IPOs average market.

	Offer Price	Closing Price	Underpricing	3-y Share Price	5-y Share Price	O.Price Variation	C.Price Variation	Und. Variation	3y S.P. Variation	5y S.P. Variation
VC-backed	\$15,061	\$19,672	29,314%	\$26,589	\$33,697	-	-	-	-	-
Non-VC-backed	\$16,942	\$19,889	16,834%	\$22,398	\$24,703	-	-	-	-	-
Energy VC-backed	\$16,611	\$17,561	5,761%	\$19,908	\$21,783	\$1,550	-\$2,111	-23,553%	-\$6,681	-\$11,914
Energy non-VC-backed	\$19,275	\$21,714	11,347%	\$22,820	\$22,726	\$2,333	\$1,825	-5,487%	\$0,422	-\$1,977
Materials VC-backed	\$14,656	\$16,736	15,460%	\$32,464	\$25,648	-\$0,405	-\$2,936	-13,854%	\$5,875	-\$8,049
Materials non-VC backed	\$17,799	\$20,654	12,730%	\$30,126	\$32,864	\$0,857	\$0,765	-4,104%	\$7,728	\$8,161
Industrials VC-backed	\$13,554	\$17,223	26,766%	\$22,994	\$23,489	-\$1,507	-\$2,449	-2,548%	-\$3,595	-\$10,208
Industrials non-VC-backed	\$16,148	\$18,221	12,296%	\$21,083	\$23,050	-\$0,794	-\$1,668	-4,538%	-\$1,315	-\$1,653
Cons. Discret. VC-backed	\$18,649	\$25,663	38,850%	\$35,067	\$49,101	\$3,588	\$5,991	9,536%	\$8,478	\$15,404
C. Discret. non-VC-backed	\$16,359	\$21,551	30,055%	\$22,915	\$26,630	-\$0,583	\$1,662	13,221%	\$0,517	\$1,927
Health Care VC-backed	\$12,669	\$16,561	26,635%	\$20,105	\$24,676	-\$2,392	-\$3,111	-2,679%	-\$6,484	-\$9,021
H. Care non-VC-backed	\$13,221	\$15,918	21,552%	\$16,043	\$19,914	-\$3,721	-\$3,971	4,718%	-\$6,355	-\$4,789
Financials VC-backed	\$18,128	\$22,086	22,950%	\$29,395	\$29,800	\$3,067	\$2,414	-6,364%	\$2,806	-\$3,897
Financials non-VC-backed	\$18,380	\$20,498	10,931%	\$20,581	\$21,771	\$1,438	\$0,609	-5,903%	-\$1,817	-\$2,932
Info. Tech. VC-backed	\$15,431	\$21,140	33,028%	\$30,951	\$44,287	\$0,370	\$1,468	3,714%	\$4,362	\$10,590
Info. Tech. non-VC-backed	\$15,524	\$19,336	23,694%	\$29,389	\$35,044	-\$1,418	-\$0,553	6,860%	\$6,991	\$10,341
Com. Services VC-backed	\$16,389	\$21,062	37,296%	\$29,381	\$35,525	\$1,328	\$1,390	7,982%	\$2,792	\$1,828
Com. Serv. non-VC-backed	\$18,232	\$21,396	17,279%	\$17,987	\$13,684	\$1,290	\$1,507	0,445%	-\$4,411	-\$11,019
Real Estate VC-backed	\$17,625	\$19,349	9,115%	\$22,982	\$28,238	\$2,564	-\$0,323	-20,199%	-\$3,607	-\$5,459
R. Estate non-VC-backed	\$16,222	\$17,177	5,067%	\$20,678	\$25,173	-\$0,720	-\$2,712	-11,767%	-\$1,720	\$0,470

Table VIII – Share price variation per capital structure.

As concerns to the offer price, Industrials and Health Care saw, their prices below average for both capital structures, as well as Materials VC-backed, Consumer Discretionary, Real Estate and Information Technology non-VC-backed issues. On the other side, Financials and Consumer Discretionary companies with venture capitalist support stood out with \$3,067 and \$3,588 per share, respectively, above the market sample.

At the end of the first day, all capital structures maintained their record, apart from Energy VC-backed IPOs, which passed from \$1,550 above to \$2,111 below the market, and Consumer Discretionary non-VC-backed IPOs where occurred the opposite, since the difference moved from -\$0,583 to \$1,662. The Financials and Consumer Discretionary VC-backed IPOs continued to hold the highest positive variations.

In the 3-year share price, three variables presented a negative difference higher than 6 dollars per share in comparison the market, which were the Health Care sector and Energy companies with VC assistance. On the other hand, Information Technology and Materials firms without the presence of VCs registered their share prices of \$6,991 and \$7,728 above the benchmark, whilst Consumer Discretionary VC-backed companies reached a \$8,478 upper value against the market.

Furthermore, more than half of the variables increased negatively the gap, however sectors such as Information Technology, Consumer Discretionary VC-backed and Materials non-VC-backed increased positively their variation and beat the market by at least \$8 a share.

4.4. Multiple regression

This model is a statistical technique that predicts the outcome of a certain variable through numerous explanatory variables. Therefore, the multiple regression defines the relationship between the independent variables and dependent variables. In this particular case, I use it to analyze the impact of the sectors, venture capitalists, offer price, closing price and stock exchange in the first day underpricing, 3-year performance, 3-year to 5-year performance, 5-year performance, 3-year share price and 5-year share price⁵.

In summary, I utilize the ordinary least-squares (OLS) regression that is given by the following model:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_k x_{ik} + \varepsilon_i \quad (4)$$

Where the dependent variable is represented by y . Since I am going to perform six different models for the 544 IPOs (i.e., for the level of underpricing, 3-year, 3-year to 5-year and 5-year performance and 3-year and 5-year share price of the company i), the y_i will take different variables.

The β_0 is the interception between the regression line and the dependent variable and is given by a constant term, while the other betas (β_k) are the coefficients for each independent variable x_k . The type of sector, venture capitalists, offer price, closing price, stock exchange and first day underpricing are the independent variables x , whereas ε_i denotes the model's error term, also known as residuals for each company i .

Hereupon, I display the criteria defined for the dummy⁶ variables, where I apply a similar approach as Boon (2014), and the dependent and independent variables implemented in each regression. Moreover, the dummy variables will be the same in all regressions and are identified in table IX.

In order to avoid the dummy variable trap⁷, the Communication Services and NYSE variables were not declared and will serve as our base case. That is, the other sectors will be compared to Communication Services, whereas NASDAQ and NYSE American will have the

⁵ For the long-term dependent variables, I also analyze the impact of the underpricing.

⁶ A dummy variable assumes only the values 0 or 1 to indicate the absence or presence of some categorical effect that can influence the outcome.

⁷ The dummy variable trap emerges when two independent variables are multicollinear. That is, two or more variables are highly correlated and hence, one variable can be predicted through the others.

New York Stock Exchange as their reference. Statistically, the inclusion of these two variables does not provide extra information to the regression model, in fact, the regression would not produce an outcome if all the dummy variables were accounted.

Moreover, since I do not have evidences that an independent variable affects the relationship of another explanatory variable with the dependent one, I did not add any interaction term⁸ to the model.

⁸ An interaction term is required when X_1 affects the relationship between X_2 and Y . In other words, in a scenario where X_1 modifies the effect that X_2 has on the dependent variable. It is expressed by the product of the two independent variables.

Dummy variables	Criteria
Type of Sector:	
<i>Energy</i> – d_1	The value one is assigned if the IPO company belongs to the Energy sector. In the remaining situations, the value 0 is attributed.
<i>Materials</i> – d_2	The value one is assigned if the IPO company belongs to the Materials sector. In the remaining situations, the value 0 is attributed.
<i>Industrials</i> – d_3	The value one is assigned if the IPO company belongs to the Industrials sector. In the remaining situations, the value 0 is attributed.
<i>Health Care</i> – d_4	The value one is assigned if the IPO company belongs to the Health Care sector. In the remaining situations, the value 0 is attributed.
<i>Financials</i> – d_5	The value one is assigned if the IPO company belongs to the Financials sector. In the remaining situations, the value 0 is attributed.
<i>Information Tech.</i> – d_6	The value one is assigned if the IPO company belongs to the Information Technology sector. In the remaining situations, the value 0 is attributed.
<i>Comm. Services</i> – d_7	The value one is assigned if the IPO company belongs to the Communication Services sector. In the remaining situations, the value 0 is attributed.
<i>Real Estate</i> – d_8	The value one is assigned if the IPO company belongs to the Real Estate sector. In the remaining situations, the value 0 is attributed.
Stock Exchange:	
<i>NASDAQ</i> – d_9	The value one is assigned if the IPO company was listed on the NASDAQ. In the remaining situations, the value 0 is attributed.
<i>NYSE American</i> – d_{10}	The value one is assigned if the IPO company was listed on the NYSE American. In the remaining situations, the value 0 is attributed.
Venture Capital – d_{11}	The value one is assigned if the IPO is VC-backed. For non-VC-backed IPOs the value 0 is attributed.

Table IX – Definition of the dummy variables.

4.4.1. Underpricing regressions

For the first regression we have as dependent variable the level of underpricing y , whilst offer price x_1 and closing price x_2 are designated as the independent variables. Given that these two variables are highly correlated (0,87), I will perform two regressions for the level of underpricing, one with the offer price and other with the closing price, to avoid the problem of multicollinearity.

Therefore, this leads to the following model:

$$\begin{aligned} \text{Underpricing} = & \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3d_1 + \beta_4d_2 + \beta_5d_3 + \beta_6d_4 + \beta_7d_5 \\ & + \beta_8d_6 + \beta_9d_7 + \beta_{10}d_8 + \beta_{11}d_9 + \beta_{12}d_{10} + \beta_{13}d_{11} \end{aligned} \quad (5)$$

4.4.2. Performance regressions

The 3-year, 3-year to 5-year and 5-year performance consist in the data computed through the annual growth rate and exhibit the same information, but for different time periods. For that reason, the independent variables will be the same, which in this case are the offer price x_1 , closing price x_2 and level of underpricing x_3 . In order to analyze exclusively the impact of the underpricing, I will perform three regressions, one for each independent variable.

Therefore, these models are expressed as follows:

$$\begin{aligned} \text{3_year performance} & \quad (6) \\ = & \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4d_1 + \beta_5d_2 + \beta_6d_3 + \beta_7d_4 \\ & + \beta_8d_5 + \beta_9d_6 + \beta_{10}d_7 + \beta_{11}d_8 + \beta_{12}d_9 + \beta_{13}d_{10} + \beta_{14}d_{11} \end{aligned}$$

$$\begin{aligned} \text{3_year to 5_year performance} & \quad (7) \\ = & \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4d_1 + \beta_5d_2 + \beta_6d_3 + \beta_7d_4 \\ & + \beta_8d_5 + \beta_9d_6 + \beta_{10}d_7 + \beta_{11}d_8 + \beta_{12}d_9 + \beta_{13}d_{10} + \beta_{14}d_{11} \end{aligned}$$

$$\begin{aligned} \text{5_year performance} & \quad (8) \\ = & \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4d_1 + \beta_5d_2 + \beta_6d_3 + \beta_7d_4 + \beta_8d_5 \\ & + \beta_9d_6 + \beta_{10}d_7 + \beta_{11}d_8 + \beta_{12}d_9 + \beta_{13}d_{10} + \beta_{14}d_{11} \end{aligned}$$

4.4.3. Price regressions

These regressions are very similar to the previous section, since the explanatory variables are also the offer price, closing price and underpricing. The objective of running a regression

for the 3-year share price and 5-year share price is to analyze the difference of outcomes between these dependent price variables and the dependent performance variables, as well as the influence of the independent variables on them.

Thus, the share price models are demonstrated by the following formulas:

$$\begin{aligned}
 &3_year\ share\ price && (9) \\
 &= \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4d_1 + \beta_5d_2 + \beta_6d_3 + \beta_7d_4 \\
 &+ \beta_8d_5 + \beta_9d_6 + \beta_{10}d_7 + \beta_{11}d_8 + \beta_{12}d_9 + \beta_{13}d_{10} + \beta_{14}d_{11}
 \end{aligned}$$

$$\begin{aligned}
 &5_year\ share\ price && (10) \\
 &= \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4d_1 + \beta_5d_2 + \beta_6d_3 + \beta_7d_4 \\
 &+ \beta_8d_5 + \beta_9d_6 + \beta_{10}d_7 + \beta_{11}d_8 + \beta_{12}d_9 + \beta_{13}d_{10} + \beta_{14}d_{11}
 \end{aligned}$$

4.4.4. Outputs

This section provides the outputs of the regressions aforementioned, as well as the description and explanation of its outcomes. Therefore, Table X reports the underpricing regression results, where regression 1 considers the offer price, albeit regression 2 accounts the first day closing price.

Underpricing <i>Independent Variables</i>	Regression 1			Regression 2		
	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>
Constant	0,1734	2,9623	0,01	-0,1463	-3,1832	0,01
NASDAQ	0,0675	2,1818	0,05	0,1151	4,3829	0,01
NYSE American	-0,0824	-0,5230	-	0,0126	0,0929	-
Comm. Services	-0,0342	-0,5474	-	0,0057	0,1046	-
Health Care	-0,1131	-2,3217	0,05	-0,0282	-0,6679	-
Info. Technology	-0,0516	-1,0762	-	-0,0136	-0,3275	-
Materials	-0,1648	-2,0742	0,05	-0,0926	-1,3471	-
Financials	-0,1750	-3,2278	0,01	-0,1283	-2,7348	0,01
Industrials	-0,1358	-2,6822	0,01	-0,0534	-1,2131	-
Real Estate	-0,2199	-2,8903	0,01	-0,1161	-1,7564	0,1
Energy	-0,1930	-3,3699	0,01	-0,1384	-2,7892	0,01
VC-backed	0,0845	2,7366	0,01	0,0618	2,3124	0,05
Offer Price	0,0053	2,3624	0,05	-	-	-
Closing Price	-	-	-	0,0170	13,7416	0,01
N	544			544		
Adjusted R Square	0,0807			0,3147		

Table X – Underpricing regressions output.

The first regression shows that the offer price, presence of venture capitalists and NASDAQ are positively related to the level of underpricing for a significance level of 0,05,

0,01 and 0,05, respectively. In other words, for a 1-dollar increase in the offer price, the underpricing also increases, averagely, 0,0053%. Relative to the other two variables, an IPO that has venture capital support, underprices 8,45% more than non-VC-backed IPO, on average, while a company which issues on NASDAQ underprices 6,75% more than if it was listed on NYSE, on average and holding all the other variables constant.

On the other hand, all sectors hold a negative coefficient, meaning that the Consumer Discretionary sector has the highest underpricing, when all the other variables are maintained constant. However, Information Technology and Communication Services are the only areas with a p-value higher than 0,05, which can be translated as variables that do not have a different impact in the underpricing as compared to the impact of Consumer Discretionary in the dependent variable. The same situation can be verified in stock exchanges, since the p-value of the NYSE American is also superior than 0,05. Among the remaining sectors, Real Estate has the least influence on underpricing in relation to the reference variable, since it underprices 21% less, for a 0,01-significance level.

This model is a significant predictor as the ANOVA test conceived a p-value smaller than 0,05 and its adjusted R^2 is 0,0807, that is, 8,07% of the variation in the level of underpricing is explained by the independent variables included in the model. Therefore, we can assume that 91,93% of the fluctuation in underpricing is justified by other factors that are not in the model.

The second regression predicts the level of underpricing with the closing price as the independent variable, which has a positive significant relationship with a level of 0,01, as well as NASDAQ. The presence of VCs is also positive related but for a significance level of 0,05. Thereby, the underprice increases, on average, 0,017% for each dollar rise in the closing price, NASDAQ experience, on average, 11,51% higher levels of underpricing than New York Stock Exchange, and VC-backed IPOs register averagely and holding all the variables constant, superior levels of underpricing (6,18%) as IPOs without venture capitalists' assistance.

The Financials and Energy are the only sectors with a significant relation of 0,01, which indicates that they underprice 12,83% and 13,84% less than the reference category, on average. On the other side, solely the Communication Services area has a positive coefficient, although its significance level is higher than 0,05. Furthermore, the level of underpricing in Health Care, Information Technology, Materials, Industrials, Real Estate and Communication Services is not significantly different from the underpricing in Consumer Discretionary, since these sectors own a p-value higher than 0,05.

Regarding stock exchanges, the influence of NYSE American in the dependent variable is not different from the NYSE.

This model is also a significant predictor due to ANOVA significance F result and its adjusted R^2 is 0,3147, which is higher than the first regression. In other words, the level of underpricing is explained by the independent variables in 31,47%. Hence, we can assume that, although considerably smaller, 68,53% of the underpricing variation is still explained by different factors.

In table XI I perform three regressions for the 3-year share performance, with the first including the underpricing, while the second and third considering the offer price and closing price, respectively.

3-y performance <i>Ind. Variables</i>	Regression 1			Regression 2			Regression 3		
	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>
Constant	0,0652	1,5308	-	0,1082	1,7969	0,10	0,1035	1,8884	-
NASDAQ	-0,0416	-1,3483	-	-0,0459	-1,4408	-	-0,0442	-1,4120	-
NYSE American	-0,3668	-2,2666	0,05	-0,3786	-2,3355	0,05	-0,3787	-2,3362	0,05
Comm. Services	0,0027	0,0419	-	0,0006	0,0093	-	-0,0015	-0,0227	-
Health Care	-0,0432	-0,8667	-	-0,0537	-1,0715	-	-0,0549	-1,0905	-
Info. Technology	0,0419	0,8503	-	0,0369	0,7480	-	0,0366	0,7406	-
Materials	0,0292	0,3557	-	0,0201	0,2461	-	0,0174	0,2123	-
Financials	-0,0175	-0,3109	-	-0,0230	-0,4127	-	-0,0268	-0,4800	-
Industrials	-0,0119	-0,2287	-	-0,0215	-0,4122	-	-0,0238	-0,4530	-
Real Estate	0,0188	0,2384	-	0,0063	0,0806	-	0,0025	0,0313	-
Energy	-0,0724	-1,2162	-	-0,0789	-1,3391	-	-0,0830	-1,4047	-
VC-backed	0,0642	2,0060	0,05	0,0672	2,1157	0,05	0,0688	2,1613	0,05
Underpricing	0,0372	0,8381	-	-	-	-	-	-	-
Offer Price	-	-	-	-0,0017	-0,7398	-	-	-	-
Closing Price	-	-	-	-	-	-	-0,0011	-0,7663	-
N	544			544			544		
Adjusted R Square	0,0164			0,0161			0,0162		

Table XI – 3-year performance regressions output.

As one can observe, the three regressions only have the NYSE American and VC-backed variables with a significant relation for a 0,05 level, although the coefficients are negative and positive, respectively. Furthermore, any of the other independent variables is statistically significant, since their p-values are higher than 0,05 and for that reason cannot predict the 3-year performance. The results also show that every sector has the same impact as the reference category given that the p-values assume high significances.

Indeed, the F-test significance in regression 1, regression 2 and regression 3 is extremely high, in other words, the null hypotheses are not rejected and hence, the regressions are not strong enough to propose that the offer price, underprice and closing price have an effect in the

population. In conclusion, these independent variables have no impact in the 3-year performance result.

In order to perceive if this conclusion replicates in other time periods, I analyze the 3-year to 5-year and 5-year performance regressions as they are described in tables XII and XIII.

3 to 5-y performance <i>Ind. Variables</i>	Regression 1			Regression 2			Regression 3		
	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>
Constant	0,0969	1,7210	0,10	0,1192	1,4938	-	0,0834	1,1501	-
NASDAQ	-0,0582	-1,4306	-	-0,0515	-1,2209	-	-0,0461	-1,1128	-
NYSE American	-0,0588	-0,2752	-	-0,0686	-0,3195	-	-0,0581	-0,2710	-
Comm. Services	-0,0071	-0,0841	-	-0,0110	-0,1285	-	-0,0068	-0,0795	-
Health Care	0,0529	0,8032	-	0,0400	0,6022	-	0,0492	0,7386	-
Info. Technology	0,0481	0,7393	-	0,0422	0,6454	-	0,0464	0,7091	-
Materials	0,0003	0,0031	-	-0,0179	-0,1653	-	-0,0102	-0,0944	-
Financials	-0,0554	-0,7451	-	-0,0744	-1,0064	-	-0,0696	-0,9410	-
Industrials	-0,0391	-0,5670	-	-0,0543	-0,7872	-	-0,0455	-0,6551	-
Real Estate	0,0056	0,0542	-	-0,0187	-0,1806	-	-0,0077	-0,0739	-
Energy	-0,0393	-0,4998	-	-0,0603	-0,7720	-	-0,0547	-0,6990	-
VC-backed	-0,0020	-0,0463	-	0,0072	0,1722	-	0,0049	0,1166	-
Underpricing	0,1090	1,8586	0,10	-	-	-	-	-	-
Offer Price	-	-	-	0,0004	0,1305	-	-	-	-
Closing Price	-	-	-	-	-	-	0,0017	0,8972	-
N	544			544			544		
Adjusted R Square	-0,0044			-0,0109			-0,0094		

Table XII – 3-year to 5-year performance regressions output.

As the significance of the F-tests are considerably high and the adjusted R² are negative, these regressions cannot predict the 3-year to 5-year annual growth rate and therefore, will not be considered.

5-y performance <i>Ind. Variables</i>	Regression 1			Regression 2			Regression 3		
	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>
Constant	0,0459	1,5608	-	0,0726	1,7406	0,10	0,0614	1,6184	-
NASDAQ	-0,0562	-2,6434	0,01	-0,0552	-2,5050	0,05	-0,0532	-2,4543	0,05
NYSE American	-0,2412	-2,1606	0,05	-0,2501	-2,2283	0,05	-0,2473	-2,2040	0,05
Comm. Services	-0,0101	-0,2277	-	-0,0125	-0,2812	-	-0,0122	-0,2735	-
Health Care	-0,0182	-0,5276	-	-0,0277	-0,7988	-	-0,0257	-0,7385	-
Info. Technology	0,0517	1,5198	-	0,0472	1,3821	-	0,0482	1,4094	-
Materials	0,0099	0,1747	-	-0,0013	-0,0225	-	-0,0003	-0,0049	-
Financials	-0,0231	-0,5939	-	-0,0331	-0,8567	-	-0,0333	-0,8595	-
Industrials	-0,0155	-0,4315	-	-0,0257	-0,7116	-	-0,0242	-0,6663	-
Real Estate	0,0355	0,6533	-	0,0204	0,3773	-	0,0219	0,4017	-
Energy	-0,0613	-1,4922	-	-0,0725	-1,7778	0,10	-0,0726	-1,7742	0,10
VC-backed	0,0452	2,0459	0,05	0,0502	2,2808	0,05	0,0501	2,2752	0,05
Underpricing	0,0598	1,9515	0,10	-	-	-	-	-	-
Offer Price	-	-	-	-0,0005	-0,3339	-	-	-	-
Closing Price	-	-	-	-	-	-	3,768E-05	0,0370	-
N	544			544			544		
Adjusted R Square	0,0417			0,0564			0,0348		

Table XIII – 5-year performance regressions output.

Despite the different time period, underpricing, offering price and closing price continue not to be statistically significant and therefore do not influence the 5-year growth share price. Nevertheless, NASDAQ, NYSE American and VC-backed have similar coefficients in the three regressions and are the only variables whose p-values are inferior than the significance level 0,05, except for NASDAQ in regression 1 that has 0,01.

Contrarily to the first-day results demonstrated in table X, NASDAQ's coefficients are negative, which suggests that during the five years after the issue, NASDAQ IPOs have a less yearly growth than NYSE of 5,62% in regression 1, 5,52% with the offer price as independent variable and 5,32% in regression 3, on average. In fact, NYSE is the market which performs better, on average, during the 5-time period, since NYSE American also hold negative coefficients.

Regarding the presence of venture capitalists, VC-backed IPOs grow more than firms without VC support, in the three scenarios, by 4,52%, 5,02% and 5,01%, on average per year.

All sectors have the same impact in the 5-year share price performance for the three regressions, once every p-value is higher than the significance level.

These models are a significant predictor due to ANOVA significance F results and their adjusted R^2 are very similar, with regression 2 having the best result (0,0564). In other words, 5,64% of the variation in the 5-year share price performance is explained by the offer price and the dummy variables. Thus, the majority of the variation in 5-year share price performance is justified by other factors than underpricing (95,83%), offer price (94,36%) and closing price (96,52%).

In summary, we may assume that VC-backed IPOs outperform non-VC-backed IPOs in every period of analysis and issues listed on NASDAQ have a better result in the first day, however in the long term, New York Stock Exchange IPOs register, overall, a better performance.

In the next two tables I analyze the impact of the explanatory variables abovementioned in the 3-year share price and 5-year share price.

3-y share price <i>Ind. Variables</i>	Regression 1			Regression 2			Regression 3		
	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>
Constant	29,1629	8,7343	0,01	-5,3892	-1,2750	-	3,8807	0,9855	-
NASDAQ	-9,7730	-4,0458	0,01	-2,8438	-1,2720	-	-5,3583	-2,3824	0,05
NYSE American	-19,4653	-1,5351	-	-11,3365	-0,9962	-	-12,4274	-1,0667	-
Comm. Services	-3,1834	-0,6317	-	-2,5427	-0,5634	-	-0,6951	-0,1502	-
Health Care	-7,4920	-1,9173	0,10	-1,9460	-0,5533	-	-1,6443	-0,4546	-
Info. Technology	1,0334	0,2676	-	3,7642	1,0868	-	3,6925	1,0405	-
Materials	1,3893	0,2162	-	3,4657	0,6041	-	5,6552	0,9601	-
Financials	-4,2066	-0,9537	-	-5,9657	-1,5235	-	-2,2243	-0,5536	-
Industrials	-5,7941	-1,4155	-	-2,0828	-0,5695	-	-0,4954	-0,1314	-
Real Estate	-7,6856	-1,2449	-	-4,5420	-0,8265	-	-1,4529	-0,2567	-
Energy	-5,9183	-1,2684	-	-7,4439	-1,7991	0,10	-3,4631	-0,8150	-
VC-backed	6,2032	2,4745	0,05	6,6746	2,9926	0,01	5,1713	2,2601	0,05
Underpricing	4,5650	1,3116	-	-	-	-	-	-	-
Offer Price	-	-	-	1,8564	11,5244	0,01	-	-	-
Closing Price	-	-	-	-	-	-	1,0688	10,1040	0,01
N	544			544			544		
Adjusted R Square	0,0472			0,2354			0,1983		

Table XIV – 3-year share price regressions output.

The first regression of the 3-year share price is composed by two significant relations, which are NASDAQ with a coefficient of -9,773 for a 0,01 level of significance and VC-backed that holds a 6,2032 coefficient for a given level of 0,05. In the first variable, its coefficient reports that an IPO which trades on NASDAQ has, on average, a 3-year share price inferior by \$9,773, when compared to NYSE initial public offerings. As regards to the structure of an IPO firm, the ones which are backed by a venture capitalist see their shares worth more \$6,2032 over three years than IPOs without the intervention of a VC, on average and holding all the other variables constant.

As in the other regressions where the level of underpricing is present as an independent variable, its p-value is superior in comparison to the significance level and for that reason, it does not influence the share price three years subsequently the issuance.

Once the F-test respects the level of confidence, the model is a significant forecaster of the dependent variable, although it only explains 4,72% of the fluctuation in the 3-year share price. This signifies that almost the entire variation in the dependent variable (95,28%) is influenced by other elements.

The second regression has the offer price and VC-backed for a 99% confidence interval, with the last variable having a coefficient very similar to the first regression, of 6,6746, meaning its share price is \$6,6746 higher than non-VC-backed IPOs, on average, after 3 years. Regarding

the offer price, the coefficient states that for a 1-dollar increase in the price which the firm lists in the market, the price in the third year has a \$1,8564 rise.

Furthermore, this model is significant and the adjusted R^2 of 0,2354 implies that the model is responsible for 23,54% of the variation in 3-year share price, while 76,46% are explained by different components.

Lastly, regression 3 displays that NASDAQ, VC-backed and closing price are significantly related on a 0,05, 0,05 and 0,01, respectively, with the first variable as the only with a negative coefficient. Moreover, the outcomes are aligned with the other two regressions, since NASDAQ IPOs also have a smaller 3-year share price (-\$5,3583) compared with NYSE, whereas VC-backed IPOs continue to have higher 3-year share prices (\$5,1713) than non-VC-backed IPOs in regression three, averagely. Once closing price is significant, we may state that it impacts positively, on average, by \$1,0688 in the share price after 3 years, for every \$1 increase.

This regression is also significant and the adjusted R^2 is 0,1983. Although being smaller than the regression 2, 19,83% of the 3-year share price variation is explained by the closing price and the dummy variables.

Neither NYSE American nor industry sectors have a different impact on the dependent variable, when compared to their respective category references.

In table XV I also perform the same regressions, but for the share price of year 5, with the objective of perceiving the difference of behaviour by the variables throughout the years, in this case, between year 3 and year 5.

5-y share price <i>Ind. Variables</i>	Regression 1			Regression 2			Regression 3		
	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>	<i>Coefficients</i>	<i>t Stat</i>	<i>Sign. level</i>
Constant	36,5927	7,9195	0,01	-3,1120	-0,5138	-	6,5988	1,1848	-
NASDAQ	-15,8245	-4,7338	0,01	-7,2477	-2,2622	0,05	-10,0378	-3,1557	0,01
NYSE American	-21,5037	-1,2254	-	-12,4124	-0,7612	-	-13,3264	-0,8087	-
Comm. Services	-8,7957	-1,2613	-	-8,2456	-1,2749	-	-5,8974	-0,9009	-
Health Care	-9,9433	-1,8388	0,10	-4,0821	-0,8099	-	-3,3864	-0,6620	-
Info. Technology	4,0128	0,7510	-	6,9232	1,3948	-	6,9898	1,3927	-
Materials	-6,4117	-0,7210	-	-4,9524	-0,6024	-	-2,0705	-0,2485	-
Financials	-10,6549	-1,7455	0,10	-13,7800	-2,4557	0,05	-9,1604	-1,6119	-
Industrials	-11,5346	-2,0363	0,05	-7,9736	-1,5213	-	-5,7642	-1,0806	-
Real Estate	-10,8922	-1,2749	-	-8,5054	-1,0801	-	-4,4312	-0,5535	-
Energy	-13,2732	-2,0557	0,05	-16,2313	-2,7376	0,01	-11,2961	-1,8797	0,10
VC-backed	9,8187	2,8303	0,01	10,8819	3,4048	0,01	9,0099	2,7842	0,01
Underpricing	11,3873	2,3642	0,05	-	-	-	-	-	-
Offer Price	-	-	-	2,2208	9,6207	0,01	-	-	-
Closing Price	-	-	-	-	-	-	1,3341	8,9176	0,01
N	544			544			544		
Adjusted R Square	0,0803			0,2086			0,1917		

Table XV – 5-year share price regressions output.

Contrarily to the 3-year share price regressions in table XIV, the first regression reports Industrials, Energy and underpricing with a 0,05-significance level, which means that these two sectors have a share price in year 5 of \$11,5346 and \$13,2732 inferior than Consumer Discretionary, respectively and a 1% rise in the first day underpricing causes an \$11,3873 increase in 5-year share price. Besides this, NASDAQ and VC-backed are also significantly related to the y variable for a 99% confidence, with NASDAQ presenting lower share prices than NYSE (-\$15,8245) and VC-backed IPOs seeing its price worth \$9,8187 more, after 5 years, than the other issues.

As the ANOVA test originated a p-value smaller than 0,05, this model is a significant estimator and its adjusted R² is 0,0803, in other terms, 8,03% of the fluctuation in 5-year share price is due to the variables of this model. However, 91,97% of the 5-year share price value is influenced by different factors.

Concerning the second regression, offer price, Energy sector and VC-backed register a significance level of 0,01, while NASDAQ and Financials are within the 95% confidence interval. In the type of sectors, Financials and Energy had lower share prices compared to Consumer Discretionary (\$13,78 and \$16,2313 per share, averagely and holding all other variables constant). Moreover, firms listed in NASDAQ have a price of minus \$7,2477 per share compared to NYSE organizations, whereas a VC-backed company registers more \$10,8819 per share than a non-VC-backed firm. The offer price also influences the share price five years after the issue by \$2,2208 for every dollar added to the proposed price.

In summary, this model is significant and its adjusted R^2 is 0,2086, in other terms, this regression explains 20,86% of the variation in the dependent variable. On the other side, the other 79,14% is justified by other elements.

The last regression of the table cannot argue that sectors have different effects among them in the share price of year 5, since their significance levels are not contained in the 95% confidence interval, as well as NYSE American. Nevertheless, NASDAQ, VC-backed and closing price exhibit significant relationships with the dependent variable for a 0,01 level. In fact, while VC-backed and closing price possess a positive relation (VC-backed IPOs worth more \$9,0099 per share than non-VC-backed IPOs, and companies see its share price grow \$1,3341 per each first-day closing price dollar), NASDAQ is negative related, since companies from this stock exchange worth \$10,0378 less than firms from NYSE, on average.

As the significance F-test originated a p-value smaller than 0,05, this model is a significant predictor and its adjusted R^2 is 0,1917, that is, 19,17% of the fluctuation in 5-year share price is explained by the third model.

5. Analysis of Results

This chapter exhibits the results of my research, the information which the database provides, along with the relation between these and its reasons, and the evaluation of the hypotheses presented in section 2.

According to the methodologies performed, the first hypothesis is accepted, since in the first underpricing regression every sector except the Information Technology and Communication Services is statistically significant. Through that output, we can assume that the Consumer Discretionary has a higher underpricing as Health Care, Materials, Financials, Industrials, Real Estate and Energy, whereas Information Technology and Communication Services present similar results as the reference variable. Interestingly, these three sectors are the most underpriced of our market sample.

The same cannot be said regarding the second hypothesis, since any regression manifested that certain sectors performed better than others during the first three years, between year 3 and year 5 or over the whole period of analysis. As there is no evidence that the sector where the IPO company is included influence the long-term share performance, the hypothesis is rejected.

The hypothesis 3 is also rejected as the executed regressions cannot predict whether a sector has a higher concentration of venture capitalists. As a matter of fact, we can solely declare that in this data sample, Health Care and Information Technology were the most VC-backed sectors, yet there is no evidence that this represents the population. The same situation replicates in H5 and H6, once we cannot say if the performance of firms with or without VC support is influenced by the sector, and hence, we reject this hypothesis.

On the other side, the presence of VCs in IPOs affects positively in long-term performance. In the first three years a VC-backed IPO performs approximately 6,7%⁹ more per year, on average, and during the five years outperforms by about 5% yearly, on average. Therefore, the fourth hypothesis is accepted.

Lastly, the hypothesis 7 is rejected, since the model cannot predict if a high underpriced IPO originates a better result in the long-term. Actually, the underpricing has no impact in the 3-year and 5-year annual growth as it is shown in tables XII and XIII.

⁹ The values presented are from the significant coefficient of the regression which has the highest adjusted R². As in this case the adjusted R² are similar, I used the average value.

Regarding regressions results, stock exchanges also have a relevant role in IPOs performance and share price. In the first day of trading, NASDAQ registers a better result comparing to NYSE, however this 11,5% gap in the first day is offset during the five years after the issue. Even though in the first three years both stock exchanges have the same impact in share price growth, the same is not verified when the whole time period is considered. Indeed, NASDAQ IPOs see their share price grow 5,5% less per year during the five years, in relation to NYSE. Furthermore, this last-mentioned stock exchange has a higher 3-year and 5-year share price than NYSE of \$5,36 and \$7,25. In the case of the NYSE American, we can only say that this stock exchange underperforms NYSE by about 37,50%, yearly, in the first three years and 25% per year until year five.

Besides the first-day conclusions about industry sectors, we can only assume in the long-term, that Energy and Financials have a share price worth \$13,78 and \$16,23 less than Consumer Discretionary. In relation to the remaining dependent variables, the outputs claim that each sector has no different impact from the others in share price performance.

The adjusted R^2 is a relevant model that enables to conclude the importance that certain variables have in the studied one. Through the outcomes of this formula, we can observe that the closing price has a higher effect than the offer price in the level of underpricing. This may be because with the closing price, we can understand how the market reacted to the entrance of a new IPO, as well as to its offer price. Consequently, the estimation of the underpricing level is more precise. In the long-term, neither of these two variables affect the performance of shares, however, in 3-year and 5-year share price, the offer price explains better their variations. A possible reason for this to happen is that the offer price is defined according to the value that shares might have in the future, that is, the offer price is a better predictor for the long-term, especially for the third year, when the value of the adjusted R^2 is 0,2354. In relation to 3-y and 5-y performance, the variables selected have almost no impact.

Even though any of the tests demonstrate with significance the behaviour of the IPOs per sector and per capital structure (i.e., between VC-backed and non-VC-backed), our data sample provides the idea that during 2000 to 2014, IPOs from every sector underperformed when compared to the first day. Despite that, Energy was the only sector which lost value throughout the five years.

During the first three years, Real Estate's share price grew every year on average, still, the market recorded a higher share price. The same situation was verified in Communication

Services non-VC firms, but for year 5. In addition, Financials, Health Care and Industrials had a positive growth in all periods of time, however its long-term prices were below the average market price.

On the other hand, Materials VC-backed saw its price drop 10% per year during the first three years, however its share price was \$5,875 above the market. The Energy sector experienced a similar circumstance with a not so extreme difference, since the price decreased 0,5% per year for three years and the 3-year share price presented a positive variation of \$0,422 per share against the market. Overall, Information Technology and Real Estate showed a more consistent and better performance. Furthermore, IPOs performed better in the last two years of analysis than in the first three, on average.

Conclusion

Underpricing is a phenomenon that has been present throughout the years in initial public offerings. For that reason, this paper examines long-term performance and long-term share price of underpriced American initial public offerings per sector and per capital structure, with the objective of investigating the role of industry sectors, venture capitalists, stock exchanges, offer price, closing price and first day underpricing in the long-term share price, as well as its performance throughout the first five years after the issuance. Therefore, this thesis aims to answer to certain questions such as: Do venture capitalists play a crucial role in the long-run performance? What is the impact of the industry sectors in the level of underpricing?

In order to provide evidences that enable to respond to the research questions, this study analyses a database of 544 American IPOs from 2000 to 2014, listed on NYSE, NASDAQ and NYSE American. Moreover, each initial public offering contains its industry, offer price, opening price, closing price, level of underprice and whether it has venture capitalist support or not.

Through multiple regression models, I analyzed the impact of each industry, venture capitalists, stock exchanges, offer price, closing price and underpricing in 3-year and 5-year share price and performance, as well as the effect of the first five variables in the level of underpricing.

Thus, this thesis agrees with Ritter (1984), who concluded that underpricing occurs in certain industries, since it demonstrates that sectors such as Information Technology, Consumer Discretionary and Communication Services have higher underpricing levels. Moreover, our regressions concluded that all industries impact equally in share price growth.

In relation to IPOs with venture capitalist assistance, for a 5-year period analysis, venture capitalists outperform non-venture backed companies by 5% per year, thus, supporting Brav and Gompers (1997) findings. Furthermore, as Jain and Kini (1995), our empirical results also report that VC-backed IPOs outperform in a 3-year period, in fact these companies present approximately a 6,7% higher growth per year.

Our analysis claims that stock exchanges' results are partially aligned with the impresario hypothesis of Ritter (1998), in the sense that the main market that has higher returns in the first day, on average, end up performing worse in the long run, which is the case of NASDAQ.

In conclusion, this paper affirms that the presence of venture capitalists affects positively IPOs, however this impact is too small to be considered determinant in their long-term share price, long-term performance and first-day underpricing. Furthermore, each industry has different levels of underpricing, with some being more influential than others, nevertheless only a small percentage in underpricing's variation is explained by these.

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