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Biotech IPOs: a study on the determinants of stock performance

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Abstract

This thesis investigates the short-run and long-run performance of 459 Biotech IPOs issued between 1991 and 2016 in the United States, by analyzing determinants such as the underwriter's prestige, the syndicate involved, the amount of dollars raised by the company, the financial sponsors supporting the transaction and the IPO market cycle. The findings revealed that the Biotech sample suffered from less underpricing than the overall IPO market, with an average first-day return of 7.5% against 14.9% for the Aggregate sample. The presence of a private equity firm and a larger syndicate with unique underwriters seemed to help reducing the underpricing level, while the amount of proceeds exhibited a positive correlation with the first-day return. In the long-run perspective, the findings depended on which metric was applied. The buy-and-hold returns (BAHR) indicated that Biotech IPOs experience negative abnormal returns during the analyzed period, while the cumulative abnormal return (CAR) suggested that these stocks had positive abnormal returns. The results show that Biotech IPOs backed by venture capital or private equity firms have higher long-run performance when analyzing the BAHR metric, and Biotech IPOs held in high activity periods and supported by large syndicates and prestigious underwriters perform better when analyzing the CAR metric.

Keywords: Biotech, IPOs, underpricing, short-run performance, long-run performance, abnormal-returns

This thesis derives from previous writing cooperation between the author and Gianpietro Di Vincenzo.

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1. Introduction and Motivation

1.1 Introduction

Innovation and technological development are at the core of the economic growth in the 21st century and have been responsible for providing solutions to people and industries and creating markets for products never foreseen.

The modern Biotech industry has been playing an essential role in this revolution, especially after Genentech's foundation in 1976. The company, founded by a young venture capitalist and a university professor, was a pioneer on recombinant DNA technology. Since its birth, a whole new startup approach to biomolecular and drug development was introduced, creating a very different industry from the traditional pharmaceutical sector.

As most startup business models, Biotech companies are almost always unprofitable and carry much higher risks to the investors. Such aspects are usually driven by the long development lead time, the uncertainty of research success, and the risks of the product not being approved by regulatory health agencies (Gruber, 2009). These challenges pose most Biotech companies as dependent on external financing, initially receiving a great number of investments from Venture Capitalists and eventually turning to the public market through an initial pricing offer (IPO).

However, the strategy of going public may not be as efficient as most entrepreneurs anticipate. Scholars argue that uncertainty related to the business could explain why some firms experience underpricing when they go through an IPO, culminating on large amounts of money being left at the table (e.g., Ritter, 1984; Rock, 1986; Beatty and Ritter, 1986). Moreover, other determinants may influence the pricing of these IPOs, such as the number of underwriters and their reputation, the offer size, financial sponsors, among others (e.g., Benveniste and Spindt, 1989; Megginson and Weiss, 1991; Corwin and Schultz, 2005).

The recent fraud scandal involving Theranos, a Silicon Valley blood-testing startup, raised awareness about the difficulty in understanding and valuing Biotech companies, which ultimately reflects on the ability of the underwriters and the issuing firm when setting the offering price. Previous studies suggest that technology businesses suffer more from underpricing than other industries (e.g., Karlis, 2008; Loughran and Ritter, 2004); thus, Biotech companies become an

interesting field to be analyzed.

This study focuses on evaluating the short-term and long-term performance of Biotech companies that went public between 1990 and 2016 in the United States. In line with previous research, the results show that Biotech IPOs experience a lower level of underpricing than IPOs in general (i.e., 11% for Biotech IPOs against 17.5% for all IPOs). Surprisingly, the statistical tests suggest that underpricing is higher when the amount of proceeds is the highest. However, the presence of private equity firms and a higher number of unique underwriters seem to help reducing the levels of underpricing, thus exhibiting the expected effect. Moreover, the presence of venture capital firms, the underwriter reputation, and the “hot” market period did not return significant results that could explain the underpricing. Furthermore, the long-run performance analysis shows different results when applying the cumulative abnormal returns (CARs) and the buy-and-hold returns (BAHRs). While the monthly BAHRs result in significant negative returns, the CARs seemed to overperform the market in some specific months. The long-run multivariate regression also exhibited quite different results. The BAHRs regression shows that the presence of both venture capital firms, as well as private equity firms, seemed to help enhance the long-run performance. Moreover, when analyzing the CARs regression, both the syndicate size and the underwriter prestige appear to influence Biotech stocks on having a better long-run performance; however, stocks issued during high activity periods seem to relate to the cumulative abnormal return positively. All the remaining independent variables did not return any significant effect to help explain the long-run performance.

1.2 Motivation

In recent years, the Silicon Valley watched the rise and fall of Theranos, a blood-testing Biotech startup initially perceived as a highly successful enterprise and an example of disruptive technology, being considered one of the top 10 medical innovating companies by 2013. The company managed to raise US\$ 1.4 billion in multiple rounds of investments involving Venture Capitals, Angel Investors, and Private Equities, surpassing the Unicorn status and reaching a market value of US\$ 9 billion.

As in almost any other startup company, Theranos investors had different

expectations about the value drivers that would bring profitability to the firm. Much of the investment decisions were based on future cash flow expectations and R&D successful projects, which were so specific that most investors were unable to understand fully. The demise of Theranos started in 2015 when the Wall Street Journal reported the inability of the startup's main product - the blood-testing product - to deliver accurate results. The situation was understood by investors as an impossibility to generate profits and culminated, in 2018, with a letter to shareholders announcing that the company was shutting down and the CEO being charged for conspiracy to commit fraud.

Even though this has been one unsuccessful case and mostly driven by fraud, the Biotech industry is deeply characterized by high risks and uncertainties to investors, as its foundations are severely exposed to ethical concerns and agency regulations. Therefore, it is relevant to understand how the market perceives IPOs of Biotech companies and how their stocks perform both in the short and long-run.

2. Literature Review

IPOs have been a constant field of interest among academics and investors. However, the Biotech industry has not yet been extensively examined. This section will be divided into the following parts: initially, the Biotech industry will be discussed, followed by a concise explanation of the IPO process, and finally, the relevant literature regarding short and long-run performance will be presented.

2.1 The Biotech Industry

The literal definition of Biotechnology is the manipulation through genetic engineering of living organisms or their components to produce useful, usually commercial products (Merriam-Webster, 2020). The development of this industry has contributed to a myriad of sectors, such as healthcare, agriculture, environment, industrial goods, and infrastructure.

Although academics argue that humankind has been manipulating microorganisms for more than six thousand years, in order to produce bread and fermented beverages, for example, the Biotechnology industry still had to go through an ultimate scientific breakthrough before it came into existence (Bud, 1989). It was only in 1973 that the first Biotech company, Genentech, was founded in the US by a young venture capitalist, Robert Swanson, and Stanley Boyer, a

university professor. This milestone was achieved after one successful technique allowed manipulating the genetic structure of cells to synthesize specific proteins, consequently enabling the manipulation of a wide range of proteins into therapeutic drugs (Pisano, 1997). Another important step for the industry was Genentech's IPO, in 1982, and the US Food and Drug Administration (FDA) approval of insulin to be commercialized (Gruber, 2009). Many other companies followed the successful example of Genentech, such as Gilead Sciences, Amgen, Chiron (now Novartis), and Biogen Idec (Pisano, 2006). Moreover, some of the posterior landmarks included the discovery of restriction enzymes, the first transfer of genetic material, the development of early DNA sequencing methods, and the completion of the genome sequences (Küpper, 2006).

Since then, young Biotech firms were seen as revolutionary and not only sparked hope over long-lasting health challenges but also attracted enthusiastic Venture Capitalists. Often characterized by a great amount of uncertainty, a long and expensive R&D phase, and extensive legal and ethical requirements; however, interested investors will possibly find a rather challenging industry. Bud (1989) exemplifies a habitual Biotech stock behavior with Biogen, a company that exhibited dull returns for more than a decade and suddenly had a 2000% surge in one quarter after one drug was approved by the authorities.

The Study of Drug Development report estimates that the cost of developing a drug is at US\$2.7 billion; thus, the Biotech startups are unlikely to sustain themselves through this period without receiving private investment, strike a partnership with a large pharmaceutical company or have an IPO. VC firms have been responsible for injecting the largest amount of private capital, breaking records in 2018 with US\$13.5 billion in investments. Moreover, pre-money valuations of Biotech IPOs went up almost threefold in 2018, and the number of publicly-traded Biotech companies doubled over the past six years (United States Biopharmaceuticals, 2019). In 2019, 48 Biotech firms went public on American stock exchanges; from those, oncology-focused startups are the ones who have a higher amount of proceeds after the IPO (Ritter, 2020).

2.2 The IPO Process

The issuance of stocks in a public market may be one of the most important events for any company. An IPO or a “going public” process allows a private company to offer its shares to public investors, therefore accessing new capital and

raising funds. Some of the motivations for an IPO include high investment opportunities, capital structure adjustments, and the owner's need for liquidity (Lowry et al., 2017). This process, however, is usually challenging for all agents involved.

When a company decides to go public, the first step is to hire an investment bank to advise and underwrite the offering. When there are multiple investment banks, one of them is selected as the lead or book-running manager and becomes the major player to decide on the offering price, the number of shares to be issued, and how to allocate them among investors. The lead manager is also responsible for selecting a group of underwriters that constitute the syndicate and assist in the transaction. Often, companies will select the underwriters considering their reputation, expertise, and quality of research coverage in the company's specific industry (Binay and Pirinsky, 2007; Lowry et al., 2017).

The most popular type of underwriting arrangement is called Firm Commitment, however, alternatives such as Best Effort, Direct Listing, and Dutch Auction also exist. In a Firm Commitment, the underwriter purchases the entire issue of securities from the company and then attempts to resell the securities to the public. The difference between the price at which the underwriter buys and subsequently sells the stocks is called the gross spread and is usually set as 7% of gross proceeds. In addition, the underwriters often are entitled with an over-allotment, or greenshoe option, which allows them to sell an additional 15% of the agreement. If the issue is successful and its price goes up in the aftermarket, the underwriter exercises the over-allotment option, receives the proceeds from the additional 15% of shares, and covers its short position. Alternatively, if the issue is less successful, the underwriter covers its short position by buying back some of the over-allotment shares from the market, thereby supporting the stock price of the newly traded company (Wilhem, 2005; Lowry et al., 2017).

Although the company is already trading publicly, the IPO process *per se* is not concluded, and the underwriters play an important role in stabilizing the aftermarket. The final stage of the IPO starts after the "quiet period" is over. During the "quiet period", the company and its insiders are prohibited from making any forward-looking statements, a limitation that forbids underwriter analysts from making earnings. Finally, the underwriter's role evolves in the aftermarket period into an advisory and evaluatory function (e.g., Michaely and Womack, 1999; Cliff and Denis, 2004; Ljungqvist, Marston and Wilhelm, 2006).

2.3 IPOs Underpricing

Some of the first studies about IPOs' underpricing were conducted during the 1970s (i.e., Stoll and Curley, 1970; Logue, 1973; Reilly, 1973). Ibbotson (1975) found important empirical evidence of underpricing during the 1960s and conducted a further investigation on the reasons why this has become a normal practice. The topic became especially *in vogue* after the Internet Bubble, which was responsible for astonishingly high first-day returns of newly traded companies. Subsequently, Ritter (1984) and Ritter and Welch (2002) conducted a review on the theory and evidence of IPO activity between 1980-2001. The studies found that, at the end of the first day, shares of the new publicly issued firms traded, on average, at 18.8% above the offering price.

Ljungqvist and Wilhelm (2003) focused on IPO pricing during the DotCom bubble. They found that, prior to the Bubble period, first-day returns of IPOs averaged 17%. During the Bubble, however, the underpricing level rose, on average, to 73% in 1999 and 58% in 2000, and reached surprisingly 89% when considering only Internet IPOs. In addition, Karlis (2008) analyzed the Internet industry and advocated that such companies were more underpriced than established companies, primarily because investment bankers face higher uncertainty while pricing the initial offers.

More recently, Tanda and Anderloni (2014) investigated Life Science companies that held their IPOs in Europe between 2002 and 2007. In line with the literature, they found that the whole sample of firms presented a positive underpricing of around 12% for the first day. Conversely, Guo, Lev, and Zhou (2005) found surprising results when analyzing Biotech IPOs in the US, issued between 1991 and 2000. In their sample, the first-day underpricing was 13%, hence at a lower level than that of all IPOs, around 20%. Although Biotech companies hold their value on intangible assets and, therefore, they were expected to suffer more from information asymmetry, the authors argued that these firms disclose a great amount of information in the IPO prospectus, which helps to reduce the information asymmetry and consequently reducing the underpricing.

Although this topic has been extensively studied, there is no consensus about what drives this underpricing behavior. Therefore, the following sections will present a summary of the theories related to this subject.

2.3.1 Information Asymmetry

Information asymmetry is the most prominent theory used to explain IPO underpricing (Rock, 1986; Beatty and Ritter, 1986; Barron, 1992; Michaely and Shaw, 1994; Loughran and Ritter, 2004). It is explained by the inequality of information held by each key participant in an IPO process, those being the issuing firm, the investors, and the underwriters of the IPO.

In the case of the issuing firm holding more information than the investor, rational investors fear what Akerlof (1970) called “the lemon problem”. The theoretical concept refers to an information asymmetry that arises when buyers and sellers do not hold equal amounts of information about a product. Since the buyer cannot be certain about the true value of an asset, he will bid at a discounted price to prevent himself from buying an overpriced product, namely, a “lemon”.

Rock (1986) introduced a model of underpricing distinguishing between informed and uninformed investors. Informed investors are able to identify if the shares being offered at a given price are overpriced or underpriced, whereas uninformed investors are unable to draw such a distinction and subscribe either to both offering cases or to none. This results in a dilemma, in which uninformed investors will only be allocated shares when informed investors do not consider subscribing to the offer. Therefore, to ensure that uninformed investors will gain a positive expected initial return and, thus, have an incentive to join the IPO, issuing firms will underprice their shares. Employing Rock's model, Beatty and Ritter (1986) were able to prove that the higher the investor's uncertainty about an IPO's value once the shares start publicly trading, the more he expects the offering to be underpriced. Hence, for a high-risk IPO, the uninformed investor would require a greater underpricing to compensate for this scenario where the asymmetry of information is even larger. Moreover, posterior research reported similar results regarding this reaction of information asymmetry on underpricing (e.g., Michaely and Shaw, 1994).

In addition, subsequent studies (e.g., Sherman and Titman, 2002; Lowry, Officer, Schwert; 2010) noted that the presence of information asymmetry should also affect the accuracy of the price-setting process. Specifically, it should be more difficult to estimate the value of a firm that is characterized by high information asymmetry; hence firms with higher uncertainty should have higher volatility of initial returns. Relating the theory with the object of this study, the Biotech industry

could be perceived as a high-uncertainty group, especially if we consider that these companies hold their value in intangible assets that are difficult to be understood by outside investors. In addition, this industry is often characterized by its highly competitive nature and, in order to mitigate the asymmetry of information, it would be necessary to disclose details that could potentially harm the success of the business.

2.3.2 Underwriters Role and Reputation

Another relevant theory that concerns IPO underpricing refers to the role of the underwriter on reducing the amount of money left on the table (e.g., Logue, 1973; Beatty and Ritter, 1986; Benveniste and Spindt, 1989; Titman and Trueman, 1986; Maksimovic and Unal, 1993). The theory revolves around the idea that higher quality advisors are able to lower the information asymmetry and contribute to lower underpricing. While investigating the 1970s and 1980s, Carter and Manaster (1990), and Michaely and Shaw (1994) found evidence that high-quality underwriters provide "certification" that the issuance contains low-risk characteristics, therefore lowering the initial returns. More recently, similar studies supported these findings (Carter, Dark, and Singh, 1998; Wang and Yung, 2011).

Benveniste and Spindt (1989) developed a model where they included the information advantage of the market participants. During the book-building, if investors value the firm higher than the valuation initially done by the company, then the underwriter would be able to adjust the offering price and to raise more funds for the client. However, investors are not compelled to share their higher valuations, as they would prefer to buy the shares at a lower price. The authors note that, since underwriters conduct several IPOs throughout the years, negotiations of this kind will repeat and develop a reputation for themselves. Hence, in order to reduce the risk of the IPO being severely underpriced, the underwriter will agree only to incorporate a part of the positive valuation perspective shared by the investors. In exchange for the information, these investors are allocated more underpriced shares throughout the years. All agents benefit from this interaction, and the underwriter grows its relevance in the market (Benveniste and Spindt, 1989). Further extending this model, Sherman (2000) and Sherman and Titman (2002) find similar results where underwriters are able to price the issuance of the shares more accurately.

However, Loughran and Ritter (2004) report that, during the Internet bubble

period, prestigious underwriters were responsible for increasing underpricing. The authors suggest that such results could be explained by the fact that issuers became more focused on analyst coverage, therefore willing to accept higher underpricing in return for higher quality analyst coverage. Because the higher quality analysts tend to be concentrated among the banks that represent the highest quality underwriters, this will cause a positive relation between underwriter rank and underpricing (Loughran and Ritter, 2004).

Nevertheless, some papers advocate that IPOs may be punished if there are conflicts of interest between the issuing firm and the underwriters (e.g., Reuter, 2006 Nimalendran et al., 2007). Goldstein, Irvine, and Puckett (2011) find a positive relationship between the commissions that investors pay and the allocations of hot IPOs that they can expect to receive, therefore rewarding investors that provide benefits to the bank. However, underwriters' concern for their long-term client relationships limits the practice.

2.3.3 Syndicate Size

Proceeding from the analysis of the relationship between underwriters and investors, Corwin and Schultz (2002) focused on the syndicate composition and the ability they have to produce information. The authors argued that the number of underwriters involved in the process could reduce the level of underpricing, because when the syndicate size increases, so does the accuracy of the offer price, given that a higher number of valuations and more diverse underwriters might have a better perception of the market value.

2.3.4 "Hot" Market

As first documented by Ibbotson and Jaffe (1975) and subsequently by Ibbotson, Sindelar, and Ritter (1988), the IPO market is characterized by intense volatility over time. The authors suggest that "hot" markets are characterized by a period of large initial returns, followed by periods of "heavy" volume accompanied by relatively low initial returns. Eventually, these "heavy" issue markets are replaced by periods of low initial performance and "light" volume. Ritter (1984) found supporting results for the theory, when analyzing the "hot" market between January 1980 and March 1981 and the "cold" market comprising the rest of the 1977 to 1982 period. For the hot market, Ritter reported an average initial return of 48.4%, while for the cold period the average underpricing was considerably lower,

at 16.3%

More recently, Loughran & Ritter (2004) found an average underpricing of 65% during the DotCom bubble from 1999-2000, while it had a significant decrease to 12% during the "cold" period that followed, from 2001 to 2003. Furthermore, Ljungqvist et al. (2006) argue that the "hot" issue markets could be explained by irrational investor behavior, where investors would grow less risk-averse, and such irrationality could be explained by the speculative bubble hypothesis.

2.3.5 Financial Sponsorship

The pioneers to carry a study on VC-backed IPOs were Megginson and Weiss (1991). They compared Venture Capital-backed IPOs to non-Venture Capital-backed IPOs, between January 1983 and September 1987, and found that the first-day returns of VC-backed IPOs are significantly lower than those of non-VC backed IPOs. Subsequent research has supported these findings (e.g., Chemmanur and Loutskina, 2006; Tanda and Anderloni, 2014) and maintain the argument that venture capitalists guarantee the true value of the firm by participating in the screening, monitoring, and advising processes, which should decrease the level of information asymmetry and, consequently, decrease the level of underpricing.

On the contrary, Lee and Wahal (2004) found the underpricing trend to be 5-10% higher among the VC-backed firms, with this difference being more pronounced during the "bubble period". They argue that the results may be attributed to endogeneity: companies backed by venture capital tend to belong to riskier industries that are more difficult to value, therefore increasing the amount of money left on the table. Moreover, several studies did not find significant differences on the underpricing suffered by VC-backed and non-VC backed IPOs (e.g., Brau et al., 2003; da Silva Rosa et al., 2003), which can be understood as an inability to limit the underpricing, even with the VC firms providing monitoring and revealing information about their investees. In addition, capitalists may also influence initial returns through a grandstanding effect. Gompers (1996) explained that grandstanding refers to the incentives of younger VCs to take companies public earlier, to increase their reputation. In those situations, the VC firm is willing to incur the costs of bringing a company public earlier than it would otherwise be optimal, which translates in higher underpricing.

The role of private equity firms (PE) in setting an accurate offer price is

based on a close collaboration with the underwriters, in order to reduce information asymmetries and prevent high underpricing. Bergström, Nilsson, and Wahlberg (2006) found that PE-backed IPOs exhibit a lower degree of underpricing compared to non-PE-backed IPOs. They argued that being PE-backed works as a “certification” that the issuing firm is a highly qualified investment, therefore reducing the IPO’s uncertainty and the need to compensate investors with underpricing.

2.4 Long-Run Performance of IPOs

Intrigued by previous evidence that at some point after going public the abnormal returns on initial public offerings may be negative (e.g., Stoll and Curley, 1970; Ibbotson, 1975; Stern and Bornstein, 1985), Ritter (1991) wrote a prominent study reporting that, over a 3-year holding period, newly issued IPOs, held in the US between 1975 and 1984, underperformed when compared to a sample of similar firms, in terms of size and industry, on American stock exchanges. A subsequent study conducted by Loughran and Ritter (1995) corroborates this anomaly. The authors showed that IPOs have been poor long-run investments, delivering to investors a return of only 5% during the five consecutive years after the issue.

Moreover, the underpricing phenomenon appears to be correlated with the long-run performance of IPOs. Carter et al. (1998) investigated the relationship between initial returns and 18-month aftermarket returns and found that firms with higher initial returns tend to provide slightly lower long-run returns than firms with lower initial returns. The following paragraphs present an introduction to theories that explain the relationship between long-run performance and underpricing.

2.4.1 Underwriter Reputation and Syndicate Size

Empirical researches have indicated that IPOs conducted by high-quality underwriters tend to perform better in the long-run compared to offerings supported by lower quality underwriters (Michaely and Shaw, 1994; Nanda, Yi and Yung, 1995; Carter, Dark, and Singh, 1998; Chang, Chung and Lin, 2010; Dong, Michel, and Pandes, 2011).

This relationship is supported by the idea that prestigious underwriters, concerned with their own reputation, will ensure the veracity of the financial statement of the firm going public, therefore limiting any potential earnings

manipulation. In situations where earnings are over-inflated prior to the announcement of IPOs, the post-IPO performance of the stock is likely to suffer (Chang, Chung, and Lin., 2010). In addition, Jo et al. (2007) indicate a strong negative relationship between earnings management and underwriter reputation. However, this relationship is perceived as inconclusive, since other studies were unable to find strong evidence (Shivakumar, 2000; Fan et al., 2007)

Nevertheless, Dong, Michel, and Pandes (2011) argued that an IPO supported by a larger syndicate, namely a higher number of unique underwriters, would improve the perception about the actual market, therefore better performing in the long-run.

2.4.2 Financial Sponsorship

As previously mentioned, venture capital's presence appears to help reduce IPOs' underpricing. In addition, the benefits of this partnership seem to be extended to the long-run performance, where being VC-backed helps enhance the post-IPO returns (Jain and Kini, 1995; Brav and Gompers, 1997).

Brav and Gompers (1997) compared VC-backed and non-VC-backed IPOs during a five-year period between 1972 and 1992. The authors found supporting evidence that sponsored IPOs marginally outperform non-VC-backed IPOs. One possible explanation is that venture capitalists may influence who holds the company's shares after the IPO. Brav and Gompers (1997), Field and Sheehan (2004) and Field and Lowry (2009) suggested that venture capital firms have contacts with top-tier analysts who may follow the VC-backed firm after the IPO and thus reduce asymmetric information between the firm and investors (Campbell and Frye, 2006). The literature, however, does not have a unified conclusion, and some studies indicate that VC-backed IPOs do not perform better than other IPOs in the long-run (Hamao et al., 2000).

Moreover, private equity involvement seems to enhance the long-run performance of an IPO (Bergström, Nilsson, and Wahlberg, 2006; Levis, 2011). While investigating this relationship, Levis (2011) argued that PE firms hold significant shares of the companies they invest even after the IPO, hence continuing to be involved in the operating performance of those companies. The literature on this topic is limited, and deeper research should be conducted to investigate the long-run return of sponsored and non-sponsored IPOs.

2.4.3 “Hot” Market

Empirical evidence shows that “hot” market IPOs significantly underperform normal market IPOs (Ritter, 1991; Loughran and Ritter, 1995; Purnanandam and Swaminathan, 2004; Yung, Colak and Wang, 2008; Coakley, Hadass, and Wood, 2008). The theory posits that companies take advantage of bullish time periods when IPOs are highly valued by the markets. Companies perceive investors as over-optimistic about the potential earnings of firms that go public; thus, they take advantage of this window of opportunity. Therefore, during a “hot” market, many immature companies go public, which results in usual underperformance in subsequent years. Moreover, Ritter (1991) argued that this behavior is particularly common for young growth firms.

3. Research Question and Hypotheses

The purpose of this research is to examine the short- and long-term performance of IPOs within the Biotech industry. Therefore, the main research question is:

“What IPOs characteristics have influenced Biotech’s short-term and long-term performance?”

To develop this study various hypotheses will be investigated:

3.1 Underpricing Hypotheses

Previous empirical research has shown that IPOs have consistently suffered underpricing (e.g., Ritter, 1984; Dark and Carter, 1993; Ljungqvist & Wilhelm, 2003). Therefore, the first hypothesis is:

Hypothesis 1:

H0: All IPOs in total experience no underpricing.

H1: All IPOs in total experience a significant positive level of underpricing.

Guo, Lev, and Zhou (2005) reported that between 1991 and 2000, Biotech companies had an average first-day return of 13% against 20% for all IPOs, therefore appearing to be less initially underpriced. Thus, the following hypothesis is generated:

Hypothesis 2:

H0: On average, Biotech IPOs exhibit the same level of underpricing as general IPOs.

H1: On average, Biotech IPOs exhibit a lower level of underpricing than general IPOs.

Carter and Manaster (1990) and Carter et al. (1998) argued that IPOs taken public by prestigious underwriters benefit from superior certification leading to investors not feeling like they need a large discount on these offers. Therefore, a negative correlation is expected, and the third hypothesis is:

Hypothesis 3:

H0: A higher level of underwriter reputation has no effect on the underpricing of Biotech IPOs.

H1: A higher level of underwriter reputation has a negative effect on the underpricing of Biotech IPOs.

Corwin and Schultz (2002) argued that a larger syndicate size reduces the level of underpricing by increasing the accuracy of the offer price. Therefore, the fourth hypothesis is generated:

Hypothesis 4:

H0: A larger syndicate has no effect on the underpricing of Biotech IPOs.

H1: A larger syndicate has a negative effect on the underpricing of Biotech IPOs.

Jog and Riding (1987) and Clarkson and Merkley (2009) found that the underpricing of Canadian IPOs was significantly related to the proceeds from the offer. Therefore, the fifth hypothesis is:

Hypothesis 5:

H0: A company's offer size has no effect on the degree of underpricing.

H1: A company's offer size has a negative effect on the degree of underpricing.

Tanda and Anderloni (2014) found the underpricing of Life Science IPOs to correlate negatively with the presence of VC firms. Similarly, previous studies argued that PE firms help reduce the underpricing by sharing information about the

company, allowing the underwriters to issue shares at a more accurate price (Bergström, Nilsson, and Wahlberg, 2006). Hence, the sixth hypothesis is generated:

Hypothesis 6:

H0: IPOs backed by financial sponsors exhibit the same level of underpricing as non-sponsored IPOs.

H1: IPOs backed by financial sponsors exhibit a higher level of underpricing than non-sponsored IPOs.

Lowry and Schwert (2002) indicated that IPOs listed during periods of high IPO activity experience lower levels of underpricing. Hence, the eighth hypothesis tests whether high IPO activity affects the level of underpricing negatively.

Hypothesis 7:

H0: High IPO activity has no significant effect on the level of underpricing of Biotech IPOs.

H1: High IPO activity has a significant negative effect on the underpricing of Biotech IPOs.

3.2 Long-Run Hypotheses

Regarding the long-run performance, the theory around IPOs points towards underperformance, and this pattern is most significant for junior growing companies (Ritter, 1991). As Biotech companies are often classified as startups, the eighth hypothesis is meant to test whether these IPOs experiences such anomaly:

Hypothesis 8:

H0: Biotech IPOs do not experience a significant underperformance in the long-run.

H1: Biotech IPOs experience a significant underperformance in the long-run.

De Bondt and Thaler (1987) and Ritter (1991) advocated that long-run underperformance is the normal correction to the typical underpricing phenomenon. Therefore, the ninth hypothesis will test:

Hypothesis 9:

H0: There is no relationship between the initial return and the long-run return of Biotech IPOs.

H1: There is a negative relationship between the initial return and the long-run return of Biotech IPOs.

Ritter (1991) and Schultz (2003) posited that the long-run IPO underperformance is stronger after years with strong IPO activities. Thus, the following hypothesis is generated:

Hypothesis 10:

H0: High IPO Activity period has no effect on the long-run performance of Biotech IPOs.

H1: High IPO Activity period has a negative effect on the long-run performance of Biotech IPOs.

Empirical researches have indicated that involving high-quality underwriters in an IPO enhances the company's long-run performance (e.g., Michaely and Shaw, 1994; Nanda, Yi, and Yung, 1995; Cartel et al., 1998; Chang, Chung and Lin, 2010). Thus, the next hypothesis is:

Hypothesis 11:

H0: A higher level of underwriter reputation has no effect on the long-run performance of Biotech IPOs.

H1: A higher level of underwriter reputation has a significant positive effect on the long-run performance of Biotech IPOs.

Previous research found supporting evidence that IPOs sponsored by VC firms marginally outperform non-VC-backed IPOs in the long-run (e. g. Jain and Kini, 1995; Brav and Gompers, 1997). Similarly, private equities firms were also found to help enhance the long-run performance of IPOs (Bergström, Nilsson, and Wahlberg, 2006; Levis, 2011). To test this relationship, the following hypothesis is generated:

Hypothesis 12:

H0: On average, Biotech IPOs backed by financial sponsors exhibit the same long-run performance as non-sponsored Biotech IPOs.

H1: On average, Biotech IPOs backed by financial sponsors exhibit higher long-run performance compared to non-sponsored IPOs.

4. Data Collection and Variable Generation

The following section presents the steps applied to collect and treat the dataset required to answer the research question.

4.1 Data Collection

4.1.1 Biotech IPO Sample

For the development of this study, the Biotech sample was obtained from the SDC Platinum database from Thomson Financial. The platform was chosen because it enables the selection of industries according to the SEC's Security Industry Classification (SIC). In addition, previous studies (Loughran and Ritter, 2004; Ritter, 2020) have thoroughly identified which SIC codes are related to the Biotech industry, therefore supporting further this choice. Finally, the Biotech sample comprehends the following subsets:

Table 4.1 Biotech Industry Classification

| SIC Code | Description |
|----------|---|
| 2833 | Medicinal, Chemical & Botanic Products |
| 2834 | Pharmaceutical Preparations |
| 2835 | In Vitro & In Vivo Diagnostic Substances |
| 2836 | Biological Products, Except Diagnostic Substances |
| 8731 | Commercial Physical and Biological Research |

The initial Biotech dataset comprised information about 1,740 companies that held their IPOs in the US between January 1st, 1990, and December 31st, 2016. The start date relates to the period when Biotech IPOs started gaining momentum, especially after the US Food and Drug Administration (FDA) approved insulin for marketing (Gruber, 2009). The end date is set to allow for the three-year window necessary to calculate the proposed long-run performance. For each of the companies, the following data is retrieved: the name of the issuing company, the respective stock tickers, the stock issuance date, offer price, proceeds amount in dollars, type of security issued, the primary exchange where the stock was listed, underwriting syndicate, venture-backed flag (yes/no) and private equity-backed flag (yes/no).

Following the data collection, specific filters were applied to arrive at a final dataset (table 4.1 summarizes the procedure). Initially, 300 penny stocks IPOs (i.e., stocks with offer price below five dollars) were excluded from the sample, following Ibbotson, Sindelar, and Ritter's (1988) argument that including these offerings may affect the calculation of equally-weighted average initial return by increasing the underpricing significantly. Subsequently, the type of security is analyzed, and those IPOs characterized by the issuance of "unit offerings" and American depositary receipt (ADRs) were deleted, reducing the sample by 736 firms. Companies not listed on CRSP within 14 days of the IPO were also excluded from the sample; those were 27 firms. These steps are consistent with the vast majority of academic research (Lowry et al., 2017).

Moreover, some additional steps were necessary to ensure the computation of short-run and long-run performance. First, the Wharton Research Data Service (WRDS) was accessed to check if each of the 677 remaining companies has the first-day closing bid-ask average time series and the closing bid-ask average of every consecutive month. Surprisingly, 124 stocks did not have their time series registered and were excluded from the sample, which resulted in 533 IPOs between 1991 and 2016, since there were no IPOs left for the year 1990. The final and most challenging process consisted of gathering missing information of 205 transactions that had no record of the underwriters involved. In order to overcome this issue, each IPO prospectus (i.e., S-1 or F-1 filings) was searched and the necessary data retrieved from public sources (e.g., SEC website); therefore, the information about the syndicate and underwriters were manually extracted from there into this study's dataset. This procedure allowed to reduce the missing information, and only 94 IPOs were deleted. Finally, the Biotech sample holds complete information about 459 IPOs.

Table 4.2 Sample Selection Procedures

| Sample Characteristics | Number of Firms |
|---|------------------------|
| Biotech companies issued between 1990–2016 | 1,740 |
| Excluding penny stocks (< U\$ 5) | 300 |
| Excluding unit offerings, ADRs | 736 |
| Excluding companies not listed on CRSP within 14 days after the IPO | 27 |
| Excluding firms with no available time series | 124 |
| Excluding firms with no available prospectus | 94 |
| Final sample | 459 |

4.1.2 Aggregate IPO Sample

Subsequently to the Biotech sample generation, a list of all IPOs held in the US between January 1st, 1991, and December 31st, 2016, irrespective of industry or SIC code, was retrieved from the Eikon database from Thomson Reuters. The sample consists of 9,392 IPOs and contains the following data: the name of the issuing company, the respective stock tickers, the stock issuance date, offer price, first-day closing price, proceeds amount in dollars, type of security issued, the primary exchange where the stock was listed and underwriting syndicate.

Similar to what was done to the Biotech dataset, some of the initial filters were also applied to this sample. Initially, excluding penny stocks IPOs and, next, cleaning the transactions that had "unit offerings" or ADRs issuance. Filtering for companies that were listed on CRSP within 14 days after the IPO would be too time-consuming, hence the filter was not applied, and 7,161 IPOs remained (Table 4.3 summarizes the steps). However, one further adjustment was necessary. Because the Biotech sample was obtained through a different database, 255 IPOs were not present on the Eikon retrieved data when a cross-checking analysis was conducted. To avoid a sample selection error and further statistical mistakes, those 255 IPOs belonging to Biotech were added to the aggregate sample, comprising 7,416 in total at the end. One alternative to the issue would have been to discard the initial Biotech sample and to extract a new one from the Eikon's dataset, however, the platform does not classify companies following the SIC code, which allows for a sounder Biotech industry identification.

Table 4.4 contains the final list with 459 Biotech IPOs and 7,416 Aggregate

IPOs, distributed by year. The median volume of IPOs per year was 253 and 10 for the Biotech sample. One interesting fact regarding the underpricing was: while the Aggregate sample had a median of 10.3%, the Biotech apparently suffered from less underpricing with a median of 7.7%.

Table 4.3 Aggregate IPO Sample Selection Procedures

| Sample Characteristics | Number of Firms |
|---|------------------------|
| All companies IPOs between 1990–2016 excluding penny stocks (< U\$ 5) | 9,392 |
| Excluding unit offerings, ADRs | 7,161 |
| Including the missing Biotech companies | 255 |
| Aggregate IPOs sample | 7,416 |

Table 4.4 Distribution of Initial Public Offerings

| Year | Number of IPOs | | Proceeds Amount (U\$ M) | | Underpricing | |
|--------------|-------------------|-----------------|-------------------------|-----------------|-------------------|-----------------|
| | Aggregate IPOs | Biotech IPOs | Aggregate IPOs | Biotech IPOs | Aggregate IPOs | Biotech IPOs |
| 1991 | 332 | 5 | 25,758.8 | 151.5 | 12.0% | 15.7% |
| 1992 | 488 | 2 | 37,453.6 | 66.8 | 8.6% | 26.4% |
| 1993 | 673 | 2 | 179,363.3 | 26.0 | 11.2% | 0.8% |
| 1994 | 486 | 2 | 84,859.5 | 33.0 | 8.7% | 1.6% |
| 1995 | 454 | 6 | 2,552,128.3 | 149.2 | 20.8% | 2.9% |
| 1996 | 689 | 36 | 92,374.2 | 1,038.6 | 14.8% | 8.6% |
| 1997 | 507 | 19 | 63,572.1 | 615.9 | 12.9% | 8.7% |
| 1998 | 325 | 9 | 80,353.8 | 316.4 | 24.6% | 4.9% |
| 1999 | 472 | 9 | 75,702.4 | 2,166.0 | 66.6% | 27.8% |
| 2000 | 341 | 40 | 77,717.6 | 2,921.2 | 53.8% | 22.5% |
| 2001 | 108 | 5 | 42,997.1 | 345.7 | 12.9% | 10.2% |
| 2002 | 113 | 4 | 32,726.4 | 533.8 | 6.1% | -7.2% |
| 2003 | 107 | 6 | 34,379.7 | 300.2 | 8.9% | -17.4% |
| 2004 | 254 | 27 | 352,991.8 | 1,554.2 | 9.4% | 7.3% |
| 2005 | 222 | 15 | 43,096.9 | 1,204.8 | 9.2% | 8.0% |
| 2006 | 211 | 22 | 46,527.4 | 2,000.4 | 10.2% | 3.8% |
| 2007 | 274 | 23 | 64,881.4 | 1,726.6 | 9.8% | 2.5% |
| 2008 | 36 | 1 | 27,718.7 | 5.8 | 2.8% | -4.8% |
| 2009 | 71 | 4 | 35,567.8 | 1,148.2 | 8.9% | -1.5% |
| 2010 | 156 | 12 | 45,202.9 | 778.5 | 5.0% | -0.4% |
| 2011 | 123 | 8 | 37,759.3 | 488.4 | 2.2% | 5.7% |
| 2012 | 139 | 11 | 42,248.4 | 764.4 | 9.5% | 10.1% |
| 2013 | 252 | 41 | 72,207.5 | 5,950.6 | 14.9% | 19.0% |
| 2014 | 309 | 76 | 90,437.0 | 6,580.9 | 14.6% | 10.2% |
| 2015 | 184 | 48 | 31,872.3 | 4,213.5 | 17.2% | 19.0% |
| 2016 | 90 | 26 | 13,950.3 | 2,148.7 | 10.5% | 10.1% |
| Total | 7416 | 459 | 4,283,848.3 | 37,229.3 | 14.9% | 7.5% |
| Average | 285 | 18 | 164,763.4 | 1,431.9 | 14.9% | 7.5% |
| Median | 253 | 10 | 45,865.1 | 771.5 | 10.3% | 7.7% |

4.1.3 Long-Run Performance Data and Benchmark Data

As previously mentioned, the monthly closing bid-ask price data were collected from the WRDS. The long-run performance of Biotech IPOs is the subject of interest in this study, thus only their respective time series are necessary to be retrieved. The time frame of this dataset was extended in order to incorporate 36 trading months of IPOs held until December 2016; therefore, the dataset comprises information from January 1st, 1991 to December 31st, 2019.

Finally, one last dataset was collected and set as a benchmark to allow for both the short-run and long-run abnormal returns analysis. Thus, the NASDAQ Composite Index is retrieved from Yahoo! Finance for the period between January 1st, 1991, to December 31st, 2019. The index was selected due to the technological anatomy of the firms that compose it, therefore being the most suitable choice. Nevertheless, this approach follows a previous theoretical basis (e.g., Ainina and Mohan, 1991; Holga, Olson, and Kich, 2001).

4.2 Development of Regression Variables

4.2.1 Underwriters Reputation

The underwriter reputation variable (UnderwriterRank) follows Carter et al. (1998) reputation approach and considers the involvement of each lead or bookrunner underwriter listed in the Aggregate IPOs sample. There were 453 unique underwriters that participated in the 7,416 transactions between 1990 and 2016. The rank was constructed based on the equally-weighted average of four different criteria.

The first criterion evaluates the number of times each underwriter acted as the lead or bookrunner manager; the second criterion evaluates the number of times each distinct underwriter had been a member of the syndicate, regardless of acting as a lead manager or not. The third criterion considers the total proceeds amount for each underwriter, given that he was the lead or bookrunner manager. Finally, the fourth criterion relates to the total proceeds amount given that the underwriter was a member of the syndicate, either as lead manager or not. For each of the criteria, a rank is created following a descendent order, where the highest frequency and proceeds amount is given a value of 9 and the lowest frequency and proceeds amount receives a zero and the remaining underwriters on the list have their scores interpolated between the upper and the lower limits. Finally, the equally-weighted average of the four ranks is calculated for each underwriter and becomes their individual reputation score. The list over underwriters and their corresponding rankings can be found in Appendix 8.2.

4.2.2 Syndicate Size

The syndicate size variable (SyndicateSize) considers the number of unique underwriters involved in each Biotech IPO. As previously mentioned, the syndicate is composed by the lead underwriter and other investment banks that supported the transaction. Furthermore, the larger syndicate had twenty unique underwriters, and the average for the sample was four underwriters per IPO.

4.2.3 IPO Activity

When constructing the IPO activity dummy (HAYDummy), the number of IPOs per year was analyzed; therefore, covering the period between January 1st, 1991, and December 31st, 2016. When considering the Aggregate sample, the median of the period was 253 IPOs, resulting in the following high-volume years: the period between 1991 and 2000, as well as the years 2004, 2007, and 2014. The Biotech sample had the median volume at 10 IPOs per year and exhibited quite different high-volume periods: between 1996-1997, as well as 2004 -2007, and 2012-2016, as well as the year of 2010. Therefore, to construct the IPO activity dummy, the intersection of both samples was taken into consideration; in other words, the dummy took the value of 1 when the IPO volume was high for both samples at the same time, and 0 otherwise. Figure 4.1 presents the IPO activity per year for the Aggregate and Biotech samples. Finally, the years 1996, 1997, 2000, 2004, 2007, and 2014 were defined as high activity years.

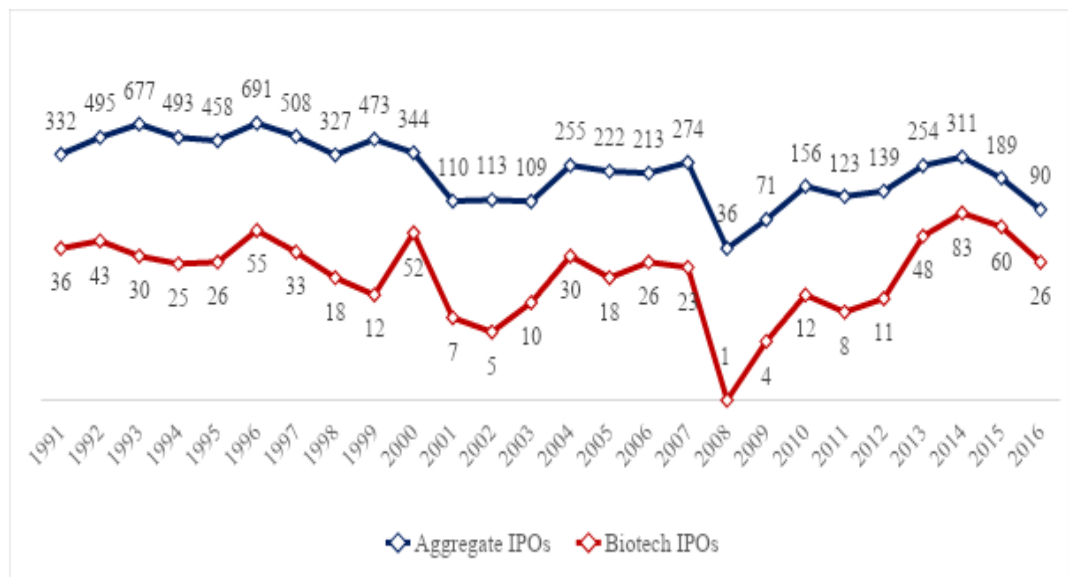


Figure 4.1 Number of Biotech IPOs and Aggregate IPOs per year between 1991 and 2016.

4.2.4 Financial Sponsors

To measure the effect of the financial sponsorship on Biotech IPOs, two dummies are generated: one for the transactions backed by venture capital firms (VCDummy) and another for the ones sponsored by private equity firms (PEDummy). It follows that VCDummy takes the value of 1 when the IPO was sponsored by venture capital, and zero otherwise. The same approach is applied to generate the PEDummy variable, where the value of 1 is given when the IPO has the support of a private equity firm, and 0 otherwise. It follows that 362 Biotech companies were VC-backed, and 29 were PE-backed, while 68 were non-sponsored (Table 4.5). Appendix 8.1 signalizes which type of sponsorship each Biotech firm received, and Appendix 8.3 presents the most reoccurring venture capitalist to invest in the Biotech industry.

Table 4.5 Financial Sponsorship Distribution

| Sample Characteristics | Number of Firms |
|---------------------------------|------------------------|
| VC-backed Biotech companies | 362 |
| PE-backed Biotech companies | 29 |
| Non-sponsored Biotech companies | 68 |

4.2.5 Proceeds Amount

The proceeds amount relates to the total funds in dollars raised by each Biotech IPO, simply calculated by the offer price multiplied by the number of shares sold. The original variable displayed a sharp skew on the right (mean > median > mode) and suffered the influence of extreme observations; thus it was necessary to transform this data by taking the natural logarithm and creating the $\ln(\text{Proceeds})$ variable, in order to create a more normalized distribution and to better fit this variable into a linear model. After the transformation, the skewness dropped from 9.1 to 0.6, therefore, making the distribution more symmetrical. Moreover, the kurtosis dropped from 99.0 to 2.9. Figures 4.2 and 4.3 present the distribution of proceeds before and after the logarithmic adjustment:

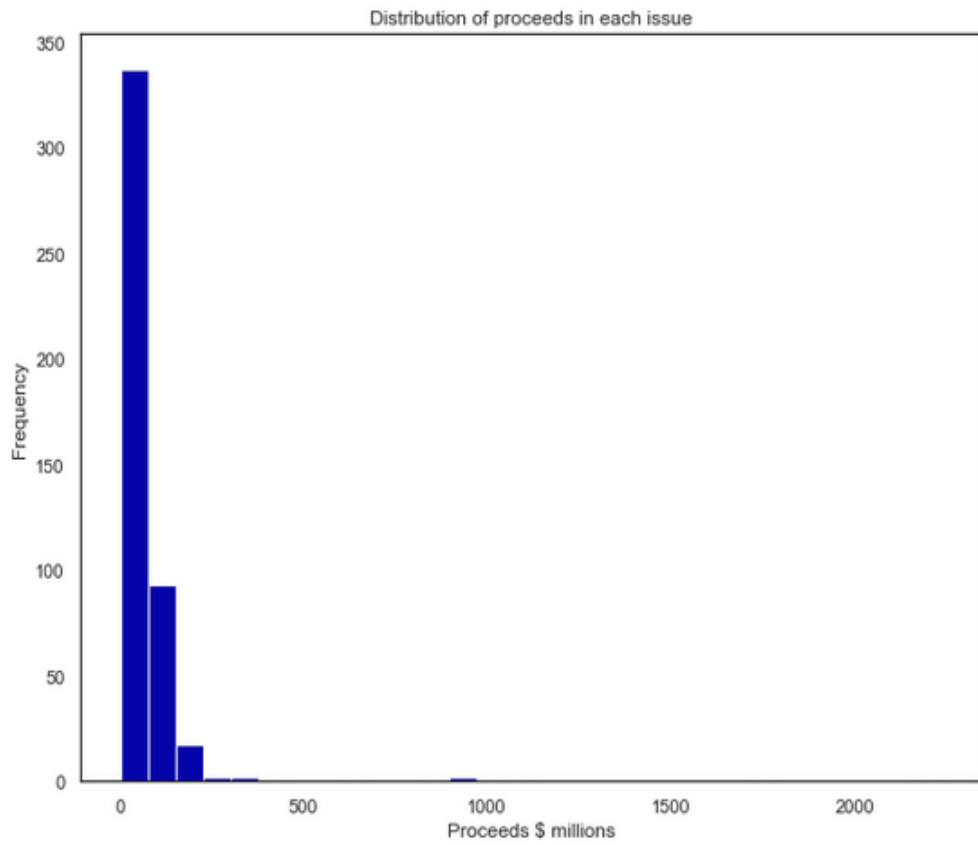


Figure 4.2 Distribution of proceeds in each IPO.

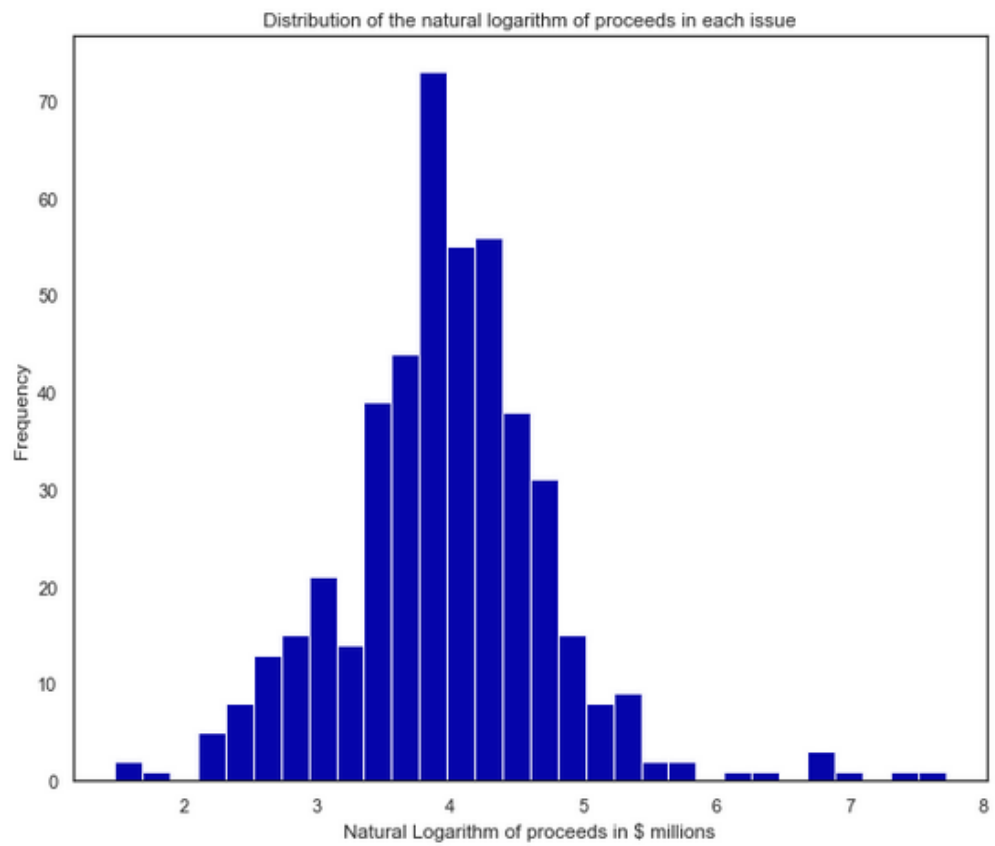


Figure 4.3 Distribution of the natural logarithm of proceeds in each IPO.

5. Methodology and Results of the Short-Run and Long-Run Performance

In the following paragraphs, the methodologies used to conduct this study are described, followed by the discussion of results, first for the short-run performance, and subsequently for the long-run performance.

5.1 Short-Run Performance

5.1.1 Measuring the Underpricing

In order to compute the short-run performance, Beatty and Ritter's (1986) methodology is applied, and the first-day closing price is defined by the average between the bid and ask prices at the end of the first trading day. Therefore, the initial returns are calculated as follows:

$$IR_i = \frac{P_{i,t_1}}{P_{i,t_0}} - 1 \quad (1)$$

Where IR_i is the return for stock i at the end of the first trading day, P_{i,t_1} is the bid-ask average closing price of the stock i on its first trading day, P_{i,t_0} is the offering price.

The following step involves calculating the return on the market index during the same period. In this study, the Nasdaq Index will be used as the corresponding benchmark, and its return is calculated as:

$$R_{m1} = \frac{P_{m1}}{P_{m0}} - 1 \quad (2)$$

Where R_{m1} is the first-day comparable market return, P_{m1} is the closing market index value on the first trading day of a particular stock i and P_{m0} is the closing market index value on the offering day of the stock.

Using these two returns, the market-adjusted abnormal return (MAAR) for each IPO on the first trading day is calculated as:

$$MAAR_i = IR_i - R_{m1} \quad (3)$$

Subsequently, to calculate the average market-adjusted abnormal return of all IPOs, there is also the need to equally-weight the firms.

$$MAAR_i^{ew} = \frac{1}{n_s} \sum_{i=1}^{n_s} MAAR_i \quad (4)$$

Where $MAAR_i^{ew}$ the equally weighted market-adjusted abnormal return of sample s , n_s is the number of IPOs in the sample s and $MAAR_i$ is the market-adjusted abnormal return of firm i .

To test whether all IPOs experience underpricing (hypothesis 1), a one-sample t-test is conducted to understand if the market-adjusted abnormal returns (MAAR) are statistically significantly different from zero. Subsequently, to test whether Biotech IPOs experience lower underpricing compared to all IPOs (hypothesis 2), a two-sample t-test is performed to understand if the difference between the two samples is statistically significantly different from zero.

5.1.2 Underpricing Analysis and Statistical Results

Initially, the Aggregate sample is analyzed, and the distribution of the first-day returns is characterized by being positively skewed, with skewness of 6.3 and excess kurtosis of 67.5. This distribution is aligned with Ibbotson's (1975) argument that an investor randomly drawing an IPO from a similar distribution has a higher chance of an extremely high first-day performance than an extremely low first-day return. Moreover, the median of this underpricing distribution was 4.3%, significantly lower than the average of 17.5% for the entire analyzed period. A Jarque-Bera test confirms that the distribution is statistically significantly different from a normal distribution ($p < 0.001$).

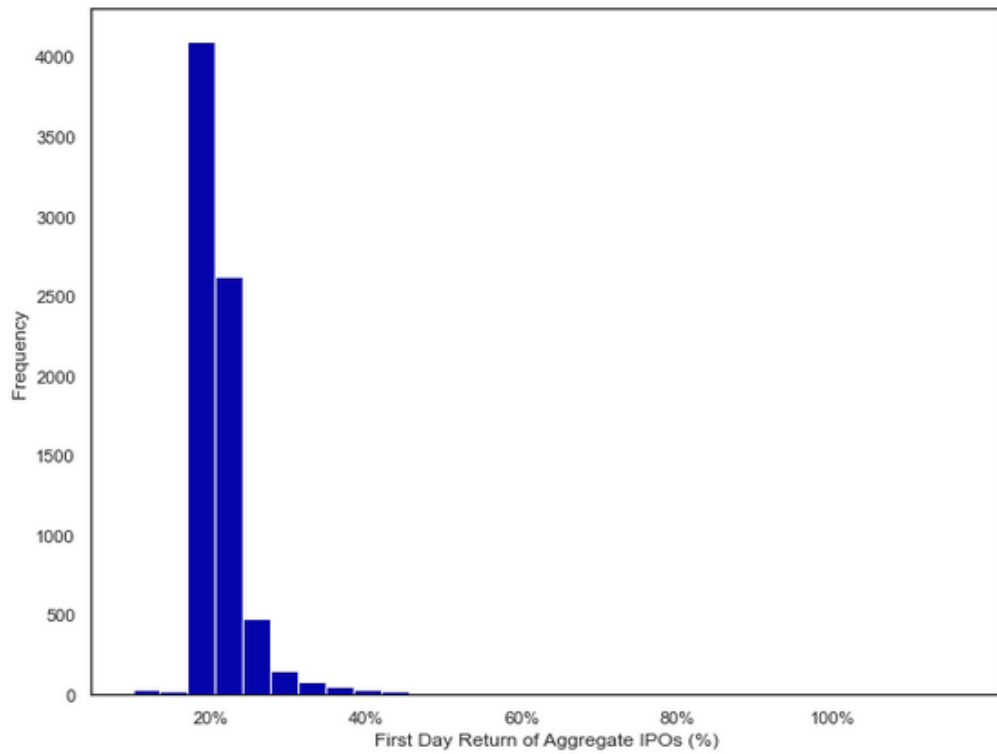


Figure 5.1 Distribution of first-day returns of the Aggregate IPOs sample.

Subsequently, the Biotech sample is observed, and the distribution returns a positive skewness of 2.8 and excess kurtosis of 15.5. Similarly to the Aggregate sample, the Jarque-Bera test rejects the null hypothesis and indicates that the underpricing distribution is non-normal ($p < 0.001$). The median first-day return for this sample was 1.9%, while the mean was substantially higher at 11.0%. This indicates that Biotech IPOs experience relatively low levels of underpricing, which contradicts the idea that industries that bear more risk are more underpriced, but corroborates to previous empirical research that found that Biotech IPOs are less underpriced than general IPOs (e.g., Guo, Lev and Zhou, 2005).

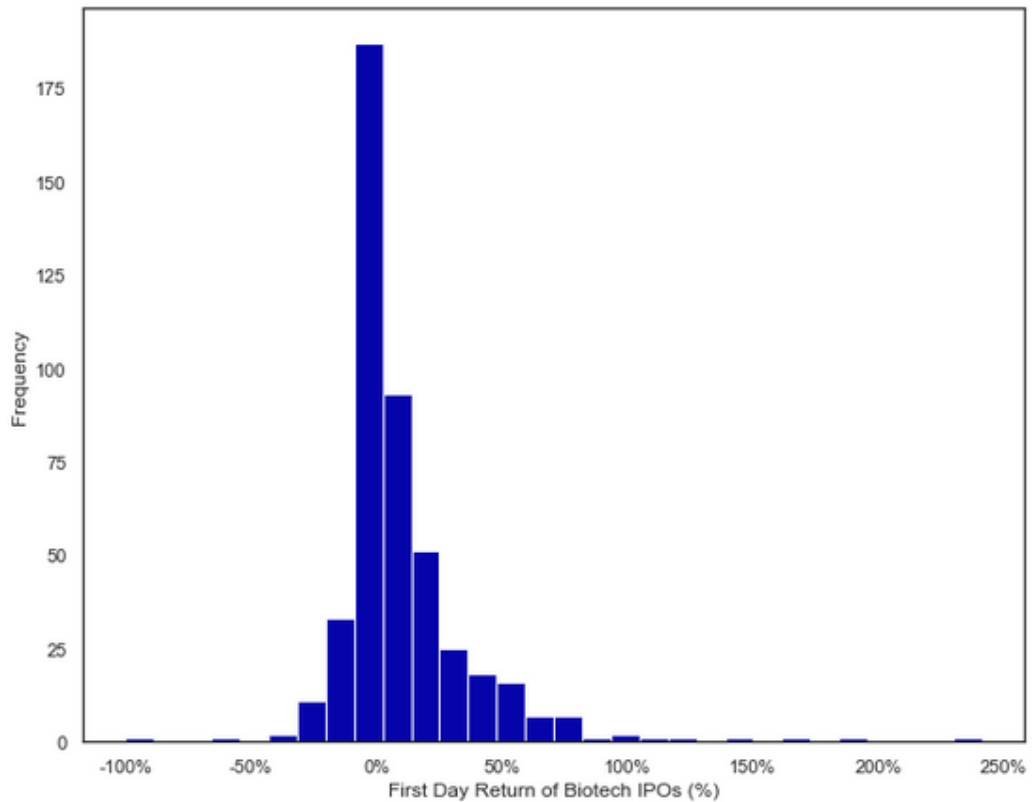


Figure 5.2 Distribution of first-day returns of the Biotech IPOs sample.

Figure 5.3 provides a comparison between equally-weighted average returns per year for each sample. The results show that the Biotech IPOs suffer less from underpricing on average than the IPOs in the Aggregate sample. It is easily observed that the underpricing level reached its highest during 1999 and 2000, in accordance with the previous literature on the DotCom Bubble. It is also worth noting that Biotech IPOs, on average, had a negative initial return during 2002, 2003, 2008, 2009, and 2010, which indicates that Biotech IPOs held in those years were overpriced. These results, however, may be driven by the fact that the Biotech sample is quite small, having very few IPOs depending on the year, which could contribute to a certain level of bias within these findings.

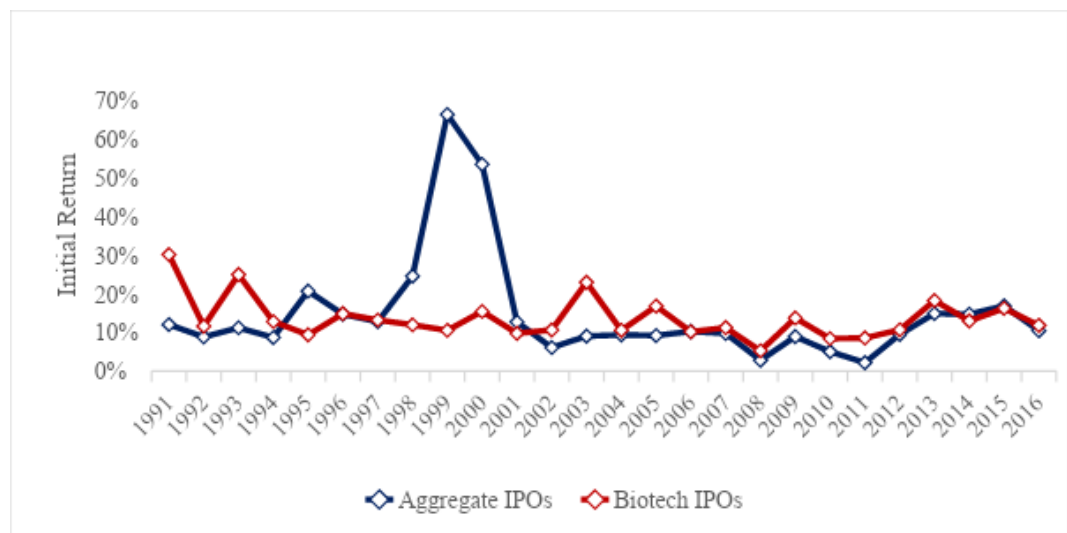


Figure 5.3 Equally-weighted first day for the Aggregate and Biotech samples.

Furthermore, a mean difference t-tests are used to test whether the equal-weighted average first-day returns are statistically significantly different from zero. When testing if all IPOs are, on average, underpriced (hypothesis 1), it was possible to find evidence of a positive and statistically significant average first-day returns for the Aggregate IPOs sample ($p < 0.001$). This result supports that all IPOs in total experience a significant positive level of underpricing, an already sedimented behavior described in previous literature (e.g., Ritter, 1984; Dark and Carter, 1993; Ljungqvist & Wilhelm, 2003). Moreover, hypothesis 2 was tested to understand if Biotech IPOs experience significantly lower underpricing compared to Aggregate IPOs. The two-sample t-test revealed that the mean underpricing of Biotech IPOs is statistically significantly lower than for the Aggregate sample; therefore, the null hypothesis was rejected ($p = 0.002$).

Table 5.1 presents the results from the t-tests performed to test hypotheses 1 and 2, as well as the mean and median of Biotech and Aggregate samples. These results indicate that Biotech IPOs are not more underpriced than the overall IPO market in the US, which states the opposite of previous research that suggests that technology companies experience a higher level of underpricing, relative to other industries, due to higher uncertainty related to these companies (e.g., Loughran & Ritter, 2004; Karlis, 2008).

Table 5.1 Mean Difference T-tests of First-Day Returns

| Sample | Mean | T-statistic | P-value | Median |
|----------------|--------|-------------|---------|--------|
| Aggregate IPOs | 17.50% | 33.9 | 0.00 | 4.3% |
| Biotech IPOs | 11.10% | 3.1 | 0.002 | 1.9% |

5.1.3 Underpricing Multivariate Regression Model

A multivariate OLS regression analysis is used to test Hypotheses 3 to 7, which seeks to understand the influence of the underwriter's reputation, the presence of financial sponsors, the amount of proceeds, and the size of the syndicate on the underpricing level. The regression has the following independent variables: *UnderwriterRank* capturing the underwriter's reputation; *ln(Proceeds)* corresponding to the size of the offering; and *SyndicateSize* relating to the number of unique underwriters involved in the IPO. Moreover, three dummy variables are included: *VCDummy* and *PEDummy* to indicate if the offering was backed by VC or PE firms, respectively, and *HAYDummy* expressing whether the IPO was issued during a high IPO activity year.

The choice of such variables is based on previous studies that have stated a relationship between them and IPO's underpricing (Carter et al., 1998; Corwin and Schultz, 2002; Lowry and Schwert, 2002; Lee and Wahal, 2004). Setting the market-adjusted abnormal returns of Biotech IPOs (MAAR) as the dependent variable, the following regression model is generated:

$$MAAR_i = \alpha_i + \beta_1 UnderwriterRank_i + \beta_2 \ln(Proceeds)_i + \beta_3 VCDummy_i + \beta_4 PEDummy_i + \beta_5 SyndicateSize_i + \beta_6 HAYDummy_i + \varepsilon_i$$

Table 5.2 contains a short explanation of each variable and its expected effect on the underpricing.

Table 5.2 Underpricing Regression Variables

| Variable | Description | Expected Correlation with Underpricing |
|------------------------|--|--|
| MAAR | Adjusted market first-day return | Dependent Variable |
| BAHR and CAR | Buy-and-Hold Return and Cumulative Abnormal Return | - |
| UnderwriterRank | Ranking from 0-9 based on the lead underwriter's reputation | Negative |
| $\ln(\text{Proceeds})$ | The natural logarithm of the amount in dollars raised from the IPO | Negative |
| SyndicateSize | Number of unique underwriters in the IPO | Negative |
| VCDummy | IPOs backed by venture capital firms | Positive |
| PEDummy | IPOs backed by private equity firms | Negative |
| HA YDummy | IPOs that occurred during years of high activity | Negative |

5.1.4 Underpricing Multivariate Regression Results

Table 5.3 displays the results from the multivariate OLS regression conducted to answer the hypotheses surrounding the underpricing of Biotech IPOs and the estimated coefficients from the set of independent variables previously presented. The first thing to note is that the model does not seem to explain a great amount of the variability in underpricing ($R^2 = 0.09$); however, the F-statistic rejects the null hypothesis at a 1% level ($F = 8.2$, $p < 0.001$). The output from the regression model, presented in Table 5.3, shows that three of the total six variables are statistically significant. Moreover, the correlation matrix (Appendix 8.4) reports that some of the variables correlate at a reasonably level: *SyndicateSize* and $\ln(\text{Proceeds})$ correlate positively (Corr. = 0.47), which could be explained by the fact that larger deals require a larger syndicate size; $\ln(\text{Proceeds})$ and *UnderwriterRank* also correlate positively (Corr. = 0.37), which could be due to the fact that the more prestigious underwriters usually support “hot” IPOs.

As expected, the *PEDummy* correlated negatively with the dependent variable and delivered a statistically significant coefficient at a 1% level ($p = 0.01$), therefore supporting the argument that the presence of PE firms allows to lower the information asymmetry around the IPO and give a certain certification on quality to the issuing firm, which helps to decrease the underpricing level of the offer. In addition, the *SyndicateSize* presented a negative and statistically significant effect

at a 5% level ($p= 0.03$), a relationship that supports the idea that larger syndicates help reducing the underpricing because the more investment bankers are involved, the better the chances of the offer being optimally priced. Surprisingly, the amount of proceeds raised by the initial offering ($\ln(\text{Proceeds})$) differed from what was initially expected, and the coefficient returned a positive and statistically significant relationship with the initial return (MAAR) at a 1% level ($p = 0.00$), which contradicts what was expected and indicates that larger offerings experience greater underpricing.

Moreover, the *UnderwriterRank*, and *HAYDummy* variables did not provide statistically significant results, which contradicts most of the studies that examine this relationship. In addition, it was not possible to find significant differences on the level of underpricing suffered by Biotech IPOs that were sponsored by venture capitalists and the ones that were not, which corroborates previous empirical evidence that the presence of VC firms is not sufficient to limit underpricing (e.g., Brau et al., 2004; da Silva Rosa et al., 2003).

Table 5.3 Underpricing Regression Results

| Coefficients | Estimate |
|---------------------|-----------------------|
| Intercept | -0.2796 (0.082) |
| UnderwriterRank | -0.006 (0.010) |
| Ln(Proceeds) | 0.1292*** (0.020) |
| VCDummy | -0.0077 (0.037) |
| PEDummy | -0.1625*** (0.063) |
| HAYDummy | -0.0072 (0.025) |
| SyndicateSize | -0.0154** (0.007) |
| R-squared | 0.098 |
| Observations | 459 |
| Degree of Freedom | 6 |
| F-statistic | 8.2 |

5.2 Long-Run Performance

5.2.1 Abnormal Returns in Event Time

Prior investigations related to long-run IPO performance contribute to diverse debates on which models are intended to measure the true abnormal returns (Ritter, 1991; Fama and French, 1993; Kothari and Warner, 1996; Brav and Gompers, 1997; Barber and Lyon, 1997; Carter et al., 1998). Two of the most common methods used to calculate the long-run performance are the cumulative abnormal return (CAR) and buy-and-hold abnormal returns (BHAR) (Ikenberry, Lakonishok, and Vermaelen, 1995; Fama, 1998; Mitchell and Stafford, 2000). While the CAR assumes that the portfolio is rebalanced each month to account for the delisted stocks, the BAHAR measures the return of buying the stock after the IPO and holding it until the stock is delisted or the analyzed timeframe has passed (Ritter, 1991). Because the CAR ignores the compounding effect of holding the stock, the returns of this metric tend to differ significantly as the time period increases (Barber and Lyon, 1997). Lyon et al. (1999) document that BHARs should be applied when trying to understand if investors earn abnormal returns by holding certain stocks over a particular time horizon, while the CAR approach should be employed when investigating if a sample of stocks persistently earns abnormal monthly returns. In addition, Fama (1998) argued that since the BHAR is naturally skewed, given its compounding approach, the CAR metric is better suited for measuring long-run performance.

In this study, both methods are applied. Initially, the market-adjusted long-run return is calculated for a period of 36 months following the first trading month, consistently with previous research (Ritter, 1991; Chi and Padgett, 2005). Hence, the market-adjusted return for stock i in t th month is defined as:

$$ar_{it} = r_{it} - r_{mt} \quad (5)$$

Where r_{it} is the return for stock i in the t th trading month and r_{mt} is the return on the market during the corresponding time period.

The average market-adjusted return on a sample of n stocks for the t th month is the equally weighted arithmetic average of the market-adjusted returns:

$$AR_t = \frac{1}{n} \sum_{i=1}^n ar_{it} \quad (6)$$

The cumulative market-adjusted long-run performance (CAR) from event month q to event month s is the summation of the average monthly market-adjusted returns:

$$CAR_{q,s} = \sum_{t=q}^s AR_{it} \quad (7)$$

The second measure we are going to use is the three-year buy-and-hold market-adjusted returns following the first trading month (BHAR), defined as:

$$BAHR_i = \prod_{t=2}^{37} (1 + r_{i,t}) - \prod_{t=2}^{37} (1 + r_{b,t}) \quad (8)$$

The mean three-year market-adjusted buy-and-hold return is defined as:

$$\overline{BAHR} = \frac{1}{n} \sum_{i=1}^n BAHR_i \quad (9)$$

Furthermore, to test whether Biotech IPOs experience significant underperformance in the long-run (hypothesis 8), specific statistical tests will be applied to each long-run performance measure. BAHRs are often heavily right-skewed with fat right-hand tails; thus, they cannot be assumed to be normally distributed (Schöber, 2008). Because this feature violates the main assumption of a t-test, an alternative one-sample sign test is used to understand whether the distribution has a median of zero. Conversely, CARs have the advantage that their distributional properties are better defined, which facilitates statistical tests of abnormality (Schöber, 2008). Therefore, a mean difference t-test is used to understand whether the CARs are significantly different from zero for each seasoning month.

5.2.2 Distribution and Statistical Results of Abnormal Returns

Initially, the distribution of the BAHAR and CAR for Biotech companies are analyzed. The 36-months CAR is characterized by being slightly positively skewed,

with skewness of 0.5 and excess kurtosis of 2.1, while the 36-months BAHR was also positively skewed with skewness of 3.1 and excess kurtosis of 15.4. The CAR distribution had an average of 9.2% and a median of -2.8%; for the BAHR, these values were -25.4% and -66.4%, respectively. In the analyzes, some outliers were identified: Onconova Therapeutics had a CAR of -360% during the 36-months period, while 24 of those months had negative returns; on the extreme positive bound, Aquinox Pharmaceuticals had a 723% CAR during the 36-months; Triangle Pharmaceuticals had the lowest BAHR at -259%, while New River Pharmaceuticals had the highest at 1158% during the 36-months period.

Moreover, the Jarque-Bera normality test was applied to the 36 months BHARs and CARs. The results for both CARs and BAHR distributions showed that they are significantly non-normal at a 1% level; therefore, the null hypothesis was rejected. This contradicts what was expected based on previous empirical results that showed CARs to have fat left-hand tails and a moderately negative skewness (e.g., Barber and Lyon, 1997; Gompers and Lerner, 2003; Schöber, 2008); however, the BAHR distribution is in line with Fama's (1998) argument that it should be skewed because of its compounding nature.

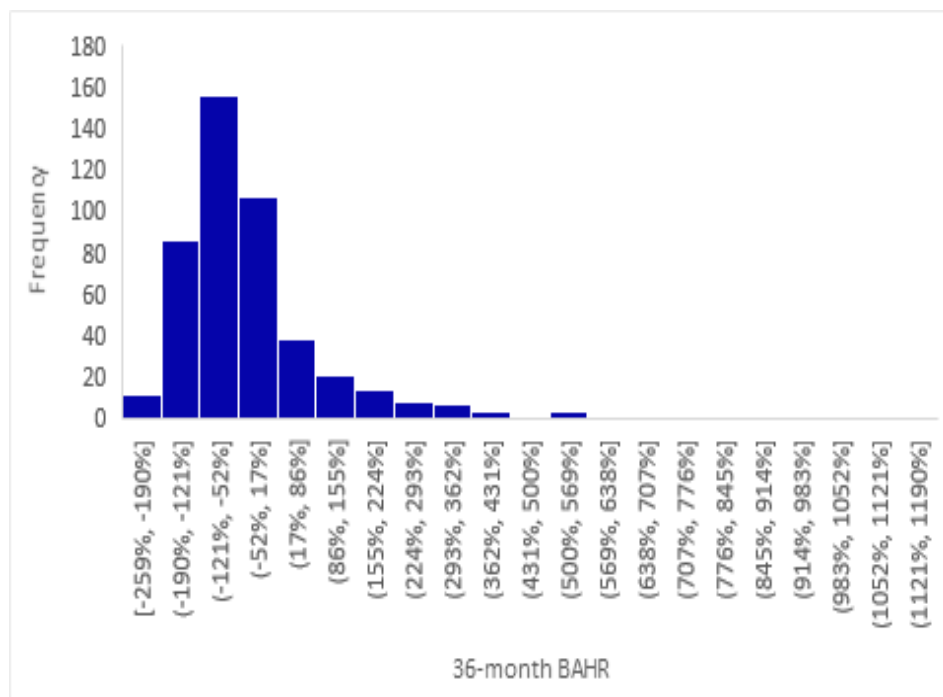


Figure 5.4 Distribution 36-month BAHR.

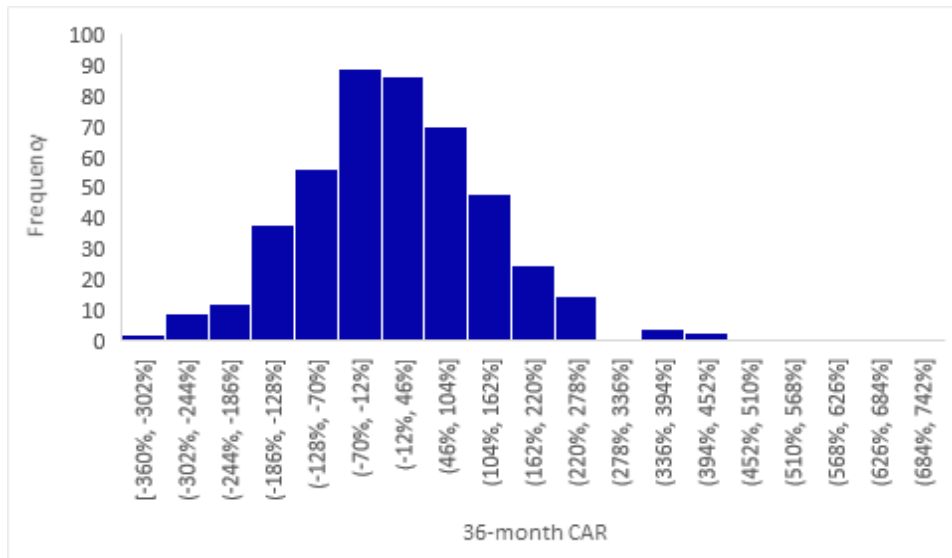


Figure 5.5 Distribution 36-month CAR.

Figure 5.6 shows the abnormal return development of both the CAR and BHAR measurements during the 36-month period after the first trading month of each stock. From the graph, it is possible to notice that BHARs show more extreme results and higher variance than the CARs due to the compounding effect of the first. Moreover, it is easily observed that Biotech stocks tend to underperform the Nasdaq benchmark, with the BAHAR having an almost all-time-negative return and the CAR barely ever having positive abnormal returns.

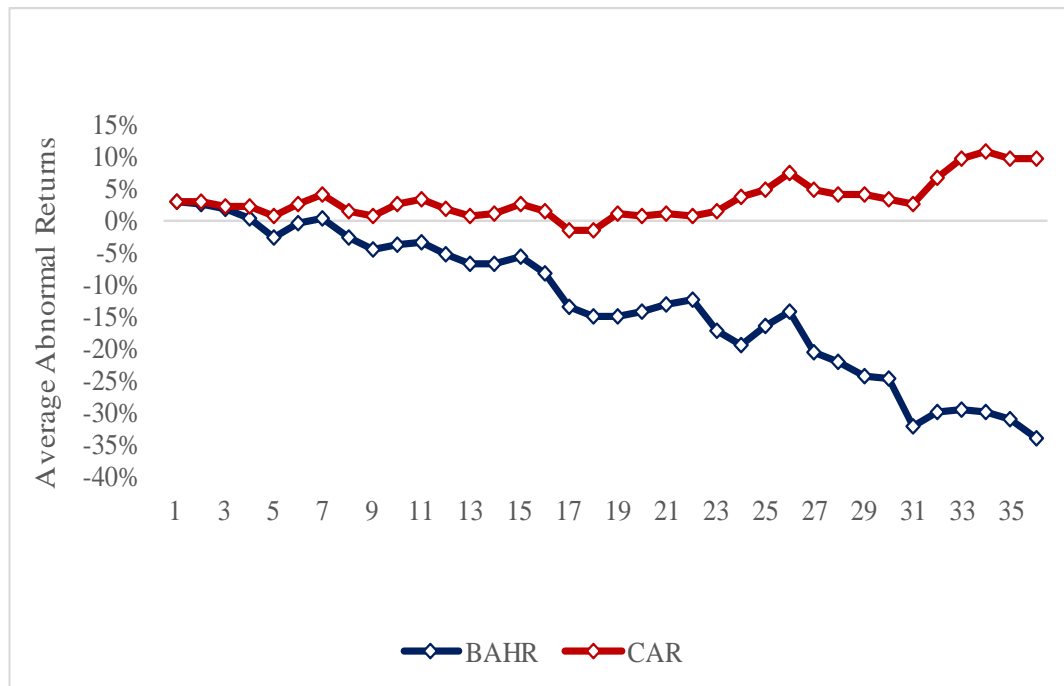


Figure 5.6 CAR and BAHAR abnormal return per each seasoning month.

Tables 5.4 and 5.5 present the results for the BAHR and CAR performances with the respective average, median, skewness, kurtosis, as well as the t-statistics from the mean difference of zero tests for each month. By observing the BAHR table, it can be noticed that out of 36 months, only three months had a positive return, and starting from the 17th month, the Biotech sample underperforms the Nasdaq benchmark at a statistically significant level. In addition, the Wilcoxon signed-test corroborates to reject the null hypothesis that the median BAHR does not differ from zero ($p < 0.001$). On the contrary, the CAR table shows that only two months exhibited a negative return, and for months 1, 35, and 36, it was possible to find positive and statistically significant abnormal returns. Thus, the statistical tests reveal that, when analyzing the BAHRs, it is possible to find support for hypothesis 8, stating that Biotech IPOs do experience a significant underperformance in the long-run, however, when analyzing the CARs performance, there is no support for the previous statement as the cumulative abnormal returns seem to perform better than the market index. Therefore, these results are only partially in line with previous research that found that IPOs underperform in the long-run (e.g., Ritter, 1991; Loughran and Ritter, 1995).

Table 5.4 Average BAHR for each seasoning month

Average BHAR per seasoning month for Bioech stocks in the sample with standard deviation, test-statistic from mean difference t-test, skewness and kurtosis. In the cases where a firm is delisted or merged, it is removed from the BAHR measurement. This results in a diminishing number of observations as more months are included.

| BAHR | | | | | | | |
|--------------|---------------------|----------------|---------------|---------------|---------------|-----------------|-----------------|
| Month | Observations | Average | St Dev | T-stat | Median | Skewness | Kurtosis |
| 1 | 459 | 3% | 28% | 2.2 | -3% | 3.8 | 30.6 |
| 2 | 459 | 3% | 38% | 1.5 | -4% | 2.8 | 16.8 |
| 3 | 459 | 2% | 49% | 0.8 | -7% | 4.9 | 49.1 |
| 4 | 459 | 0% | 50% | 0.2 | -9% | 3.2 | 21.0 |
| 5 | 459 | -3% | 47% | -1.3 | -12% | 2.2 | 9.9 |
| 6 | 459 | -1% | 54% | -0.2 | -12% | 2.2 | 10.4 |
| 7 | 459 | 0% | 62% | 0.1 | -12% | 2.0 | 6.7 |
| 8 | 459 | -2% | 62% | -0.8 | -16% | 1.9 | 5.7 |
| 9 | 459 | -4% | 61% | -1.5 | -15% | 1.7 | 4.4 |
| 10 | 458 | -4% | 64% | -1.3 | -17% | 1.9 | 7.2 |
| 11 | 457 | -3% | 74% | -1.0 | -17% | 3.2 | 19.1 |
| 12 | 456 | -5% | 79% | -1.4 | -19% | 3.3 | 22.2 |
| 13 | 455 | -7% | 78% | -1.9 | -23% | 2.5 | 10.7 |
| 14 | 454 | -7% | 97% | -1.5 | -26% | 5.3 | 50.2 |
| 15 | 453 | -6% | 113% | -1.1 | -26% | 7.5 | 94.2 |
| 16 | 452 | -8% | 107% | -1.7 | -23% | 5.4 | 51.4 |
| 17 | 450 | -13% | 99% | -2.9 | -29% | 4.2 | 31.1 |
| 18 | 448 | -15% | 98% | -3.3 | -28% | 3.4 | 20.4 |
| 19 | 446 | -15% | 100% | -3.3 | -30% | 3.2 | 18.9 |
| 20 | 444 | -14% | 111% | -2.7 | -32% | 3.8 | 23.4 |
| 21 | 442 | -13% | 125% | -2.3 | -34% | 4.6 | 31.9 |
| 22 | 440 | -13% | 142% | -1.9 | -34% | 6.5 | 65.6 |
| 23 | 438 | -17% | 120% | -3.1 | -32% | 4.2 | 27.6 |
| 24 | 435 | -19% | 109% | -3.8 | -33% | 3.4 | 21.7 |
| 25 | 432 | -16% | 124% | -2.8 | -36% | 3.7 | 21.3 |
| 26 | 429 | -14% | 134% | -2.2 | -34% | 4.0 | 24.6 |
| 27 | 426 | -21% | 122% | -3.6 | -35% | 3.5 | 20.7 |
| 28 | 423 | -22% | 129% | -3.7 | -33% | 4.2 | 27.7 |
| 29 | 420 | -25% | 127% | -4.1 | -36% | 4.1 | 27.4 |
| 30 | 417 | -25% | 138% | -3.8 | -41% | 4.1 | 25.4 |
| 31 | 413 | -32% | 113% | -6.1 | -46% | 2.6 | 12.6 |
| 32 | 413 | -30% | 120% | -5.4 | -46% | 3.0 | 16.7 |
| 33 | 409 | -30% | 119% | -5.3 | -44% | 2.5 | 10.2 |
| 34 | 404 | -30% | 119% | -5.4 | -44% | 2.4 | 10.3 |
| 35 | 398 | -31% | 123% | -5.4 | -44% | 2.6 | 12.3 |
| 36 | 391 | -34% | 125% | -5.8 | -47% | 2.4 | 9.2 |

Table 5.5 Average CAR for each seasoning month

Average CAR per seasoning month for Biotech stocks in the sample with standard deviation, test-statistic from mean-difference t-test, skewness and kurtosis. In the cases where a firm is delisted or merged, it is removed from the CAR measurement. This results in a diminishing number of observations as more months are included.

| Month | Observations | CAR | | | | | |
|-------|--------------|---------|--------|--------|--------|----------|----------|
| | | Average | St Dev | T-stat | Median | Skewness | Kurtosis |
| 1 | 459 | 3% | 30% | 2.2 | -2% | 4.2 | 34.7 |
| 2 | 459 | 3% | 37% | 1.7 | -1% | 2.4 | 13.9 |
| 3 | 459 | 2% | 42% | 1.1 | -3% | 2.3 | 15.3 |
| 4 | 459 | 2% | 45% | 1.0 | -4% | 1.7 | 8.3 |
| 5 | 459 | 1% | 46% | 0.3 | -4% | 1.3 | 6.2 |
| 6 | 459 | 2% | 53% | 1.0 | -4% | 0.9 | 2.8 |
| 7 | 459 | 4% | 58% | 1.5 | -5% | 1.0 | 3.3 |
| 8 | 459 | 1% | 61% | 0.5 | -5% | 0.9 | 3.5 |
| 9 | 459 | 1% | 62% | 0.2 | -3% | 0.6 | 2.2 |
| 10 | 458 | 3% | 64% | 0.9 | -1% | 0.3 | 2.0 |
| 11 | 457 | 3% | 69% | 1.0 | 2% | 0.4 | 2.3 |
| 12 | 456 | 2% | 71% | 0.5 | -2% | 0.4 | 2.1 |
| 13 | 455 | 1% | 73% | 0.2 | -4% | 0.3 | 2.0 |
| 14 | 454 | 1% | 78% | 0.3 | -3% | 0.6 | 3.5 |
| 15 | 453 | 3% | 81% | 0.7 | -1% | 0.8 | 3.6 |
| 16 | 452 | 1% | 89% | 0.3 | 2% | 1.7 | 11.3 |
| 17 | 450 | -2% | 90% | -0.4 | -2% | 1.6 | 10.3 |
| 18 | 448 | -1% | 94% | -0.3 | -3% | 1.5 | 9.1 |
| 19 | 446 | 1% | 94% | 0.2 | 0% | 1.4 | 7.8 |
| 20 | 444 | 1% | 97% | 0.2 | -3% | 1.4 | 7.2 |
| 21 | 442 | 1% | 99% | 0.2 | -2% | 1.2 | 6.2 |
| 22 | 440 | 1% | 103% | 0.2 | 2% | 1.1 | 5.5 |
| 23 | 438 | 2% | 102% | 0.3 | 2% | 1.1 | 5.3 |
| 24 | 435 | 4% | 103% | 0.7 | 4% | 1.0 | 4.3 |
| 25 | 432 | 5% | 107% | 1.0 | -2% | 0.9 | 3.9 |
| 26 | 429 | 7% | 111% | 1.4 | -1% | 1.0 | 3.3 |
| 27 | 426 | 5% | 113% | 0.9 | 0% | 0.9 | 3.4 |
| 28 | 423 | 4% | 114% | 0.8 | -2% | 1.0 | 3.7 |
| 29 | 420 | 4% | 116% | 0.7 | -1% | 1.0 | 4.0 |
| 30 | 417 | 4% | 119% | 0.6 | -10% | 1.0 | 3.4 |
| 31 | 413 | 3% | 120% | 0.5 | -2% | 0.9 | 3.4 |
| 32 | 413 | 7% | 122% | 1.1 | 3% | 0.8 | 3.4 |
| 33 | 409 | 10% | 122% | 1.6 | 1% | 0.8 | 3.5 |
| 34 | 404 | 11% | 123% | 1.8 | 1% | 0.9 | 3.1 |
| 35 | 398 | 10% | 125% | 1.5 | 0% | 0.8 | 2.8 |
| 36 | 391 | 10% | 126% | 1.5 | -4% | 0.7 | 2.8 |

5.2.3 Long-Run Performance Multivariate Regression Model

This study also seeks to understand the influence of the underwriter's reputation, the presence of financial sponsors, the amount of proceeds, and the size of the syndicate on the long-run performance. Therefore, to test the hypotheses 9 to 12, two multivariate regressions are generated with the 36-months CAR, and the 3-months BHAR set as dependent variables. Similarly to the underpricing model, the independent variables are: *UnderwriterRank*; *ln(Proceeds)*; *SyndicateSize*; *VCDummy*; *PEDummy*; *HAYDummy*. In addition, the market-adjusted abnormal return (MAAR) is included as an independent variable to test its effect on the long-run performance. Table 5.6 presents all variables used for the long-run regression performance.

$$36monthsCAR_i = \alpha_i + \beta_1 UnderwriterRank_i + \beta_2 ln(Proceeds)_i + \beta_3 VCDummy_i + \beta_4 PEDummy_i + \beta_5 HAYDummy_i + \beta_6 SyndicateSize_i + \beta_7 MAAR_i + \varepsilon_i$$

$$36monthsBAHR_i = \alpha_i + \beta_1 UnderwriterRank_i + \beta_2 ln(Proceeds)_i + \beta_3 VCDummy_i + \beta_4 PEDummy_i + \beta_5 HAYDummy_i + \beta_6 SyndicateSize_i + \beta_7 MAAR_i + \varepsilon_i$$

Table 5.6 Lon-Run Regression Variables

| Variable | Description | Expected Correlation with Long-Run Performance |
|----------------------|--|--|
| MAAR | Adjusted market first-day return | Negative |
| BAHR and CAR | Buy-and-Hold Return and Culmulative Abnormal Return | Dependet Variable |
| UnderwriterRank | Ranking from 0-9 based on the lead underwriter's reputation | Positive |
| <i>ln</i> (Proceeds) | The natural logarithm of the amount in dollars raised from the IPO | Positive |
| SyndicateSize | Number of unique underwriters in the IPO | Positive |
| VCDummy | IPOs backed by venture capital firms | Positive |
| PEDummy | IPOs backed by private equity firms | Positive |
| HAYDummy | IPOs that occurred during years of high activity | Negative |

5.2.4 Long-Run Multivariate Regression Results

Table 5.6 displays the results from the multivariate OLS regressions conducted to answer the hypotheses concerning the long-run performance of Biotech IPOs, as well as the estimated coefficients from the set of independent variables. Both the 36-months BAHR and the 36-months CAR models returned a very low R-squared, 0.05, and 0.04, respectively, thus they are unable to explain much of the observed variation in the long-run performance. Moreover, both the 36-months BAHR and 36-months CAR models are statistically significant at a 1% level: the BAHR model with the F-statistic of 3.61 ($p = 0.00$) and the CAR with F-statistic of 3.06 ($p = 0.00$).

For the 36-months BAHR regression, two coefficients were statistically significant: the VCDummy ($p = 0.02$) at a 5% level and the PEDummy ($p = 0.07$) at a 10% level. The results support the idea that having a financial sponsor contributes to higher long-run performance, here measured by the buy-and-hold approach. While the venture capitalist may contribute to the post-IPO performance by maintaining a close relationship with outside analysts and reducing the information of asymmetry, the private equity firms may provide a hands-on approach that helps to enhance the operational performance in the aftermarket (Brav and Gompers, 1997; Field and Lowry, 2009; Bergström, Nilsson, and Wahlberg, 2006; Levis, 2011). For the 36-months CAR regression, three independent variables were statistically significant: the SyndicateSize ($p = 0.04$) at a 5% level and the HAYDummy ($p = 0.07$) and UnderwriterRank ($p = 0.06$) at a 10% level. The results corroborate to previous evidence that found that respected underwriters and large syndicate with unique investment bankers have a positive influence on the long-run performance of a stock. Moreover, it supports the theory that investment banks are still interested in the performance of the firms they underwrote even after the IPO because they want to preserve their reputation by ensuring the veracity of the firm's financial statements. Surprisingly, the HAYDummy correlated positively with the 36-months CAR, strongly contradicting seminal papers that IPOs held during a high activity period tend to underperform the market (Ritter, 1991; Baker and Wurgler, 2000; Schultz, 2003).

Moreover, when analyzing the remaining coefficients for the BAHR regression, it was not possible to find a significant relationship between the independent variables and the 36-months BAHR, therefore contradicting previous studies that found that large first-day returns and the fact that the issuance of shares

occurred during a high activity period would negatively affect the buy-and-hold performance. In addition, it was not possible to find evidence that large syndicates and prestigious underwriters are able to contribute to a higher 36-months BAHR. Furthermore, the 36-months CAR regression did not reveal any significant effect when analyzing the influence of financial sponsors nor the impact of high initial returns.

Table 5.6 36-months CAR and BAHR Regression Results

* Significant at 10%

** Significant at 5%

*** Significant at 1%

| Coefficients | 36-months CAR | 36-months BAHR |
|---------------------|----------------------|-----------------------|
| Intercept | -1.259 (0.399) | -1.8522 (0.461) |
| UnderwriterRank | 0.0885 (0.047) | 0.0656* (0.055) |
| Ln(Proceeds) | 0.0574 (0.097) | 0.1563 (0.114) |
| VCDummy | 0.1635** (0.175) | 0.4753 (0.205) |
| PEDummy | -0.0143* (0.294) | 0.6259 (0.349) |
| HAYDummy | -0.212 (0.119) | -0.2071* (0.140) |
| SyndicateSize | 0.0673 (0.034) | -0.0498** (0.040) |
| MAAR | -0.3425 (0.0222) | -0.2769 (0.260) |
| R-squared | 0.0450 | 0.0530 |
| Observations | 459 | 459 |
| Degree of Freedom | 7 | 7 |
| F-statistic | 3.066 | 3.609 |

6. Conclusion

This study focuses on answering what IPOs characteristics affect Biotech stocks short-term and long-term performance, by examining 459 companies that held their IPOs between 1991 and 2016. The analysis of the short-run performance resulted in evidence that corroborates the hypothesis that Biotech IPOs are less underpriced, on average than the overall IPOs. These results contribute to the expansion of the literature on Biotech IPOs and return similar findings previously

stated by Guo, Lev, and Zhou (2005). Moreover, the multivariate regression analysis on the market-adjusted abnormal returns (MAAR) resulted on some interesting and significant results: the presence of private equity firms and larger syndicates appear to negatively influence the underpricing at a significant level; the amount of proceeds was the last variable to have a significant effect; however, it had a positive correlation with the underpricing level, contradicting what was originally expected. The variables relating to the underwriter reputation and venture capital sponsorship, as well as the dummy controlling for periods of high IPO activities, did not deliver any significant results.

Regarding the investigation on the long-run performance of Biotech stocks, the results diverge depending on the approach applied to measure the abnormal returns. The buy-and-hold abnormal return (BAHR) revealed a significant underperformance of the Biotech companies during most of the 36 months following first trading month, which contributes to previous findings stating that IPOs tend to underperform the market in the long-run (e.g., Ritter, 1991; Loughran and Ritter, 1995). Conversely, the cumulative abnormal return (CAR) approach resulted in higher returns when compared to the Nasdaq index; however, this overperformance appeared to be statistically significant for only two months. Therefore, while it is possible to confirm that Biotech stocks underperform the market in the long run when applying the BAHR approach, the same could not be confirmed when calculating with the CAR method. Moreover, the multivariate regressions applied to analyze the long-run performance had some significantly different results depending on if the 36-months BAHR or the 36-months CAR was applied. While analyzing the buy-and-hold returns, it was possible to find support for the theory that advocates on the positive influence that both venture capital and private equity have on the long-run performance. In addition, when analyzing the cumulative abnormal returns, both the underwriter reputation and the syndicate size seemed to positively contribute to better long-run returns. However, IPOs held during "hot" market periods seemed to perform better than stocks issued during low activity periods, which was the opposite expected effect. The remaining variables investigated in each of these two regressions did not show any significant results.

6.1 Recommendation and Future Research

This study aimed to investigate one particular industry that has not been extensively covered by the literature yet; thus, further analysis could be conducted to help understand the performance of Biotech stocks. One suggestion to obtain better representative results concerns reducing the number of IPOs transactions discarded due to missing information, therefore one could try to access alternative databases to preserve a large sample and prevent selection bias. One idea would be to analyze the role of the financial sponsors on the daily operating performance of Biotech companies before they went public. In addition, one could deepen the research by looking into the change in the number of shares held by VC and PE firms before and after the IPO, as well as analyzing how the relationship evolves and how long it takes until they exit the company. Moreover, the post-IPO performance could include variables to measure the influence of R&D expenses, the number of patents, book-to-market ratio, and control for the market share of each firm. These could help mitigating the number of omitted explanatory variables, therefore better explaining the long-term performance model, as well as the underpricing. Finally, it is worth considering analyzing firms that went public in stock exchanges outside the US, such as in Europe and Asia: this would contribute to increase the sample of Biotech companies and possibly return more significant results.

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8. Appendices

Appendix 1: Biotech IPOs

Table 8.1 List of Biotech IPOs and respective characteristics

| Issue Date | Company | MAAR | 36-months CAR | 36-months BARR | Syndicate Size | Lead Underwriter | Underwriter Reputation | VC Backed | PE Backed |
|------------|-------------------------------|------|---------------|----------------|----------------|-------------------------------------|------------------------|-----------|-----------|
| 30/07/2014 | Avalanche Biotechnologies Inc | 68% | -196% | -131% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 27/10/2005 | Accentia Biopharmaceuticals | -11% | -209% | -73% | 5 | Jefferies & Co Inc | 8 | Yes | No |
| 26/05/2004 | Acadia Pharmaceuticals | -5% | 123% | 93% | 4 | Banc of America Securities LLC | 8 | Yes | No |
| 25/10/2006 | Achillion Pharmaceuticals Inc | 7% | -44% | -73% | 1 | SG Cowen Securities Corp | 8 | Yes | No |
| 22/09/2016 | AC Immune SA | 43% | -79% | -119% | 3 | Credit Suisse | 9 | Yes | No |
| 09/02/2006 | Acorda Therapeutics Inc | 12% | 350% | 314% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 06/10/2015 | Aclaris Therapeutics Inc | 0% | -101% | -104% | 3 | Jefferies & Co Inc | 8 | Yes | No |
| 11/02/2011 | AcelRx Pharmaceuticals Inc | -9% | 165% | 199% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 07/10/2003 | Acusphere Inc | 1% | -85% | -84% | 4 | SG Cowen Securities Corp | 8 | Yes | No |
| 05/05/2015 | Adaptimmune Therapeutics plc | -6% | -11% | -86% | 4 | Leerink Partners LLC | 7 | Yes | No |
| 21/05/2013 | Alcobra Ltd | -5% | 64% | -77% | 3 | Sunrise Securities Corp | 3 | No | No |
| 13/11/2000 | Adolor Corp | 10% | 42% | 10% | 3 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 04/08/2005 | Advanced Life Sciences Hldgs | 21% | -135% | -81% | 3 | CE Unterberg Towbin | 6 | No | Yes |
| 12/12/2013 | Adamis Pharmaceuticals Corp | 0% | 3% | -80% | 1 | CRT CAPITAL GROUP LLC | 6 | No | No |
| 09/04/2014 | Adamas Pharmaceuticals Inc | -10% | 7% | -60% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 14/04/2015 | Aduro BioTech Inc | 145% | -105% | -121% | 4 | Merrill Lynch Pierce Fenner & Smith | 8 | Yes | No |
| 10/12/2004 | Adeza Biomedical Corp | 23% | 60% | 33% | 4 | UBS Investment Bank | 9 | Yes | No |
| 22/10/2010 | Aegerion Pharmaceuticals Inc | 14% | 214% | 533% | 4 | Leerink Swann & Co | 7 | Yes | No |
| 24/10/2013 | Aerie Pharmaceuticals Inc | 6% | 249% | 199% | 4 | Canaccord Genuity | 6 | Yes | No |
| 14/12/2006 | Affymax Inc | 35% | -21% | -30% | 4 | Morgan Stanley | 9 | Yes | No |
| 12/09/2014 | Affimed Therapeutics BV | -19% | -29% | -101% | 4 | BMO Capital Markets | 7 | Yes | No |
| 17/12/1991 | Affymax NV | 24% | -9% | -37% | 2 | Goldman Sachs & Co | 9 | No | No |
| 03/02/2000 | Antigenics Inc | 238% | 49% | 11% | 4 | US Bancorp Piper Jaffray Inc | 7 | Yes | No |
| 23/07/2013 | Agios Pharmaceuticals Inc | 74% | 72% | 11% | 4 | Goldman Sachs & Co | 9 | Yes | No |
| 09/08/2000 | AtheroGenics Inc | 3% | 167% | 144% | 6 | Chase H&Q | 7 | Yes | No |
| 06/04/2016 | Aeglea BioTherapeutics Inc | -1% | -3% | -67% | 4 | UBS Investment Bank | 9 | Yes | No |
| 19/07/2000 | Argonaut Technologies Inc | 56% | -115% | -36% | 3 | UBS Warburg | 8 | Yes | No |

| | | | | | | | | | |
|------------|-------------------------------|------|-------|-------|----|------------------------------------|---|-----|----|
| 22/05/2014 | Agile Therapeutics Inc | -8% | -31% | -96% | 4 | William Blair & Co | 8 | Yes | No |
| 26/03/2014 | Applied Genetic Tech Corp | 24% | -46% | -102% | 5 | BMO Capital Markets | 7 | Yes | No |
| 05/08/2015 | Aimmune Therapeutics Inc | 53% | 11% | -66% | 3 | Piper Jaffray Cos | 8 | Yes | No |
| 11/03/2014 | Achaogen Inc | 19% | 126% | 25% | 4 | Credit Suisse Securities (USA) LLC | 8 | Yes | No |
| 19/03/2014 | Akebia Therapeutics Inc | 57% | -23% | -93% | 4 | Credit Suisse Securities (USA) LLC | 8 | Yes | No |
| 07/05/2014 | Alder BioPharmaceuticals Inc | 1% | -9% | -82% | 4 | Credit Suisse Securities (USA) LLC | 8 | Yes | No |
| 01/05/2014 | Aldeyra Therapeutics Inc | -10% | 20% | -68% | 1 | Aegis Capital Corp. | 7 | Yes | No |
| 25/09/1996 | Algos Pharmaceutical Corp | 0% | -30% | -164% | 2 | Lehman Brothers | 9 | No | No |
| 22/04/2010 | Alimera Sciences Inc | 0% | 101% | -103% | 4 | Citi | 9 | Yes | No |
| 16/07/1991 | Alkermes Inc | 10% | -115% | -121% | 2 | Robertson Stephens & Co | 8 | Yes | No |
| 27/05/2004 | Alnylam Pharmaceuticals Inc | 0% | 83% | 74% | 4 | Banc of America Securities LLC | 8 | Yes | No |
| 27/03/2000 | Allos Therapeutics Inc | -26% | -15% | -20% | 13 | Chase H&Q | 7 | Yes | No |
| 26/01/2006 | Altus Pharmaceuticals Inc | 12% | -292% | -59% | 4 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 08/03/2006 | Alexza Pharmaceuticals Inc | 6% | -31% | -55% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 28/02/1996 | Alexion Pharmaceuticals Inc | 11% | -23% | -123% | 1 | Josephthal Lyons & Ross Inc | 6 | Yes | No |
| 15/05/2013 | Ambit Biosciences Corp | -7% | 147% | 87% | 4 | Citi | 9 | Yes | No |
| 26/07/2000 | Applied Molecular Evolution | 69% | -13% | -24% | 3 | CIBC World Markets Inc | 8 | Yes | No |
| 17/01/1992 | Amylin Pharmaceuticals Inc | 48% | -58% | -88% | 2 | Morgan Stanley & Co | 9 | Yes | No |
| 24/06/2014 | Amphastar Pharmaceuticals Inc | 24% | 59% | 49% | 4 | BMO Capital Markets | 7 | Yes | No |
| 04/02/1999 | AMRI | 18% | 129% | 117% | 2 | ING Baring Furman Selz LLC | 5 | No | No |
| 23/11/2010 | Anacor Pharmaceuticals Inc | 0% | 135% | 155% | 4 | Citi | 9 | Yes | No |
| 26/03/2004 | Anadys Pharmaceuticals Inc | 1% | 19% | -80% | 4 | SG Cowen Securities Corp | 8 | Yes | No |
| 10/10/1991 | Anergen Inc | 3% | -103% | -112% | 1 | HJ Meyers & Co | 6 | Yes | No |
| 01/03/2010 | Anthera Pharmaceuticals Inc | 0% | -128% | -127% | 4 | Deutsche Bank Securities Corp. | 8 | Yes | No |
| 13/12/2001 | American Pharm Partners Inc | 23% | 198% | 375% | 3 | CIBC World Markets Inc | 8 | Yes | No |
| 06/03/2014 | Aquinox Pharmaceuticals Inc | 9% | 723% | 14% | 3 | Jefferies LLC | 7 | Yes | No |
| 18/06/2014 | Ardelyx Inc | 1% | -15% | -109% | 5 | Leerink Partners LLC | 7 | Yes | No |
| 06/02/14 | Argos Therapeutics Inc | -2% | -177% | -136% | 4 | Piper Jaffray | 7 | Yes | No |
| 16/10/1996 | ArQule Inc | 10% | -64% | -202% | 3 | Hambrecht & Quist Inc | 8 | Yes | No |

| | | | | | | | | | |
|------------|--------------------------------|------|-------|-------|---|---|---|-----|-----|
| 17/11/2000 | Array Biopharma Inc | 17% | 46% | -17% | 3 | Lehman Brothers | 9 | Yes | No |
| 19/12/2006 | Artes Medical Inc | 28% | -272% | -62% | 3 | Lazard Capital Markets | 7 | Yes | No |
| 20/07/2005 | Adams Respiratory Therapeutics | 52% | 57% | 53% | 4 | Morgan Stanley | 9 | Yes | No |
| 08/11/2007 | ARYx Therapeutics Inc | -21% | -202% | -97% | 4 | Morgan Stanley | 9 | Yes | No |
| 29/05/1997 | Ascent Pediatrics Inc | 3% | -126% | -164% | 3 | Cowen & Co | 8 | Yes | No |
| 27/01/2015 | Ascendis Pharma A/S | 6% | 104% | 204% | 3 | Morgan Stanley & Co | 9 | Yes | No |
| 03/03/2005 | Aspreva Pharmaceuticals Corp | 34% | 58% | 41% | 3 | Merrill Lynch & Co. | 3 | Yes | No |
| 04/02/2014 | Auspex Pharmaceuticals Inc | 31% | 168% | 210% | 5 | Stifel Nicolaus & Co Inc | 8 | Yes | No |
| 07/11/1991 | Athena Neurosciences Inc | 42% | -86% | -90% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 15/10/2014 | Atara Biotherapeutics Inc | -3% | 20% | -90% | 3 | Goldman Sachs & Co | 9 | Yes | No |
| 23/07/2004 | Auxilium Pharmaceuticals Inc | -4% | 109% | 134% | 3 | Deutsche Bank Securities Corp. | 8 | Yes | No |
| 11/03/2010 | AVEO Pharmaceuticals Inc | 0% | -55% | -81% | 4 | Morgan Stanley | 9 | Yes | No |
| 22/05/1996 | Avigen Inc | 47% | 49% | -141% | 2 | Wedbush Securities | 8 | No | No |
| 05/11/1996 | Aviron | 0% | 52% | -104% | 3 | Robertson Stephens & Co | 8 | Yes | No |
| 16/10/2003 | Advancis Pharmaceutical Corp | 2% | 62% | -77% | 3 | Lehman Brothers | 9 | Yes | No |
| 29/09/2005 | Avalon Pharmaceuticals Inc | -10% | -179% | -74% | 3 | WR Hambrecht & Co LLC | 7 | Yes | No |
| 10/06/2015 | Axovant Sciences Ltd | 99% | -89% | -134% | 5 | JMP Securities LLC | 8 | No | No |
| 19/11/2015 | Axsome Therapeutics Inc | -3% | -89% | -102% | 3 | Ladenburg Thalmann & Co | 8 | No | No |
| 12/10/2016 | AzurRx BioPharma Inc | -10% | -153% | -147% | 4 | WallachBeth Capital LLC | 1 | No | No |
| 24/11/1997 | Bioanalytical Systems Inc | 3% | -144% | -127% | 4 | Roney & Co, Detroit, Michigan | 5 | Yes | No |
| 31/10/1996 | Boston Biomedica Inc | -9% | -136% | -217% | 2 | Oscar Gruss & Son Inc | 2 | No | No |
| 24/06/2002 | BioDelivery Sciences Intl Inc | -26% | -12% | -81% | 2 | Kashner Davidson Securities Corporation | 4 | Yes | No |
| 19/06/1996 | Bigmar Inc | 45% | -40% | -189% | 1 | LT Lawrence & Co Inc | 1 | No | No |
| 02/02/2016 | BeiGene Ltd | 18% | 152% | 292% | 4 | Morgan Stanley & Co | 9 | Yes | No |
| 19/02/2008 | Bioheart Inc | -5% | -74% | -45% | 1 | Dawson James Securities | 5 | Yes | No |
| 19/09/2013 | Bind Therapeutics Inc | -6% | -135% | -126% | 4 | Credit Suisse | 9 | Yes | No |
| 10/05/2007 | Biodel Inc | 19% | 0% | -62% | 4 | Morgan Stanley | 9 | Yes | No |
| 17/12/2014 | Bellicum Pharmaceuticals Inc | 23% | -111% | -135% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 13/02/2015 | Bellerophon Therapeutics LLC | -25% | -27% | -121% | 4 | Cowen & Co | 8 | No | Yes |

| | | | | | | | | | |
|------------|--------------------------------|------|-------|-------|---|--|---|-----|----|
| 18/06/2013 | bluebird bio Inc | 60% | 138% | 41% | 6 | Wedbush Securities, Inc. | 6 | Yes | No |
| 22/07/1999 | BioMarin Pharmaceutical Inc | 1% | 26% | -21% | 4 | US Bancorp Piper Jaffray Inc | 7 | Yes | No |
| 18/08/2015 | Benitec Biopharma Ltd | -13% | -63% | -136% | 1 | BMO Capital Markets | 7 | No | No |
| 19/07/2016 | Audentes Therapeutics Inc | 0% | 55% | 46% | 5 | Wedbush Securities, Inc. | 6 | Yes | No |
| 29/04/2015 | Blueprint Medicines Corp | 7% | 115% | 146% | 5 | Goldman Sachs & Co | 9 | Yes | No |
| 30/07/1999 | Biopure Corp | -15% | 59% | -20% | 4 | JP Morgan & Co Inc | 9 | Yes | No |
| 28/07/1997 | BioReliance Corp | 23% | -103% | -218% | 2 | Morgan Stanley & Co | 9 | No | No |
| 12/02/1997 | Biosite Diagnostics | 11% | 66% | -124% | 2 | Cowen & Co | 8 | Yes | No |
| 08/05/1996 | BioTransplant Inc | 8% | -70% | -167% | 2 | UBS Securities Inc | 8 | Yes | No |
| 28/04/2004 | Barrier Therapeutics Inc | -1% | -37% | -76% | 3 | Morgan Stanley | 9 | Yes | No |
| 24/10/2006 | Cadence Pharmaceuticals Inc | 4% | 42% | -23% | 1 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 01/10/2014 | Calithera Biosciences Inc | -6% | 103% | -45% | 4 | Citigroup Global Markets Inc | 8 | Yes | No |
| 24/06/2015 | Catabasis Pharmaceuticals Inc | 9% | -175% | -144% | 5 | Citigroup Global Markets Inc | 8 | Yes | No |
| 20/07/2006 | Cleveland Biolabs Inc | -9% | 96% | -3% | 1 | Ladenburg Thalmann | 5 | Yes | No |
| 25/10/1996 | Cubist Pharmaceuticals Inc | 7% | 56% | -88% | 3 | UBS Securities Inc | 8 | Yes | No |
| 08/04/2015 | Carbylan Therapeutics Inc | 11% | -150% | -139% | 4 | Leerink Partners LLC | 7 | Yes | No |
| 08/05/1998 | CombiChem | 0% | -20% | -61% | 3 | BancAmerica Robertson Stephens Inc | 7 | Yes | No |
| 10/06/1996 | Collaborative Clinical Researc | 9% | -135% | -194% | 2 | Vector Securities International | 5 | Yes | No |
| 08/02/2012 | ChemoCentryx Inc | 10% | -22% | -88% | 4 | Credit Suisse | 9 | Yes | No |
| 14/04/2015 | Cidara Therapeutics Inc | -1% | -93% | -111% | 6 | Leerink Partners LLC | 7 | Yes | No |
| 03/02/2012 | Cempra Inc | 1% | 136% | 296% | 4 | Stifel Nicolaus & Co Inc | 8 | Yes | No |
| 15/10/2015 | Cerecor Inc | -39% | 95% | -36% | 2 | Laidlaw & Co (UK) Ltd | 5 | Yes | No |
| 10/04/2014 | Cerulean Pharma Inc | -2% | -185% | -140% | 5 | Leerink Swann & Co | 7 | Yes | No |
| 11/08/2000 | Compugen Ltd | 11% | 75% | -12% | 5 | Fleet Boston Corp, Boston, Massachusetts | 7 | Yes | No |
| 20/06/1996 | CollaGenex Pharmaceuticals Inc | -9% | -11% | -127% | 2 | Alex Brown & Sons Inc | 9 | Yes | No |
| 15/07/2015 | Chiasma Inc | 23% | -179% | -161% | 4 | Cowen & Co | 8 | Yes | No |
| 06/11/2014 | Coherus Biosciences Inc | -7% | -14% | -92% | 3 | Credit Suisse Securities (USA) LLC | 8 | Yes | No |
| 28/07/1994 | CIMA Labs Inc | -1% | -88% | -157% | 3 | Cowen & Co | 8 | Yes | No |
| 05/05/2015 | CoLucid Pharmaceuticals Inc | -20% | 344% | 406% | 4 | Stifel Nicolaus & Co Inc | 8 | Yes | No |

| | | | | | | | | | |
|------------|--------------------------------|------|-------|-------|----|---------------------------------|---|-----|-----|
| 29/01/2014 | Celladon Corp | 0% | -107% | -129% | 4 | Barclays | 8 | Yes | No |
| 01/06/2016 | Clearside Biomedical Inc | 3% | -43% | -140% | 5 | Cowen & Co | 8 | Yes | No |
| 13/03/1992 | Collateral Therapeutics Inc | 5% | 52% | -107% | 1 | Furman Selz LLC | 7 | Yes | No |
| 15/11/2011 | Clovis Oncology Inc | -2% | 166% | 216% | 3 | Credit Suisse | 9 | Yes | No |
| 10/04/2013 | Chimerix Inc | 34% | -59% | -120% | 4 | Morgan Stanley | 9 | Yes | No |
| 24/07/2013 | Conatus Pharmaceuticals Inc | -14% | -121% | -125% | 4 | Piper Jaffray Inc | 8 | Yes | No |
| 02/10/1996 | CN Biosciences Inc | 7% | 17% | 0% | 2 | UBS Securities Inc | 8 | No | Yes |
| 12/02/2014 | Concert Pharmaceuticals Inc | 0% | 54% | -14% | 4 | Wells Fargo Securities LLC | 8 | Yes | No |
| 31/01/1996 | Connective Therapeutics Inc | 1% | -17% | -133% | 4 | Smith Barney Incorporated | 8 | Yes | No |
| 06/05/2015 | Collegium Pharmaceutical Inc | 2% | 124% | -17% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 09/08/2005 | Coley Pharmaceutical Group Inc | 19% | -8% | -79% | 4 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 02/04/2014 | Corium International Inc | 1% | 38% | -41% | 4 | Leerink Swann & Co | 7 | Yes | No |
| 14/04/2004 | Corcept Therapeutics Inc | 2% | -110% | -119% | 3 | Thomas Weisel Partners | 8 | Yes | No |
| 10/08/2009 | Cumberland Pharmaceuticals Inc | 0% | -109% | -107% | 4 | UBS Investment Bank | 9 | Yes | No |
| 07/11/2006 | Catalyst Pharmaceutical | 1% | 14% | -81% | 2 | First Albany Capital Inc | 5 | No | No |
| 18/03/1998 | CuraGen Corp | 13% | 442% | 472% | 3 | Morgan Stanley Dean Witter & Co | 8 | Yes | No |
| 23/06/2000 | Charles River Labs Intl Inc | 38% | 118% | 77% | 6 | Donaldson Lufkin & Jenrette Inc | 9 | No | Yes |
| 26/05/2004 | Critical Therapeutics Inc | 1% | -62% | -96% | 4 | SG Cowen Securities Corp | 8 | Yes | No |
| 22/03/2016 | Corvus Pharmaceuticals Inc | -4% | -69% | -135% | 5 | BTIG LLC | 4 | Yes | No |
| 01/10/1997 | Corixa Corp | 3% | 189% | 122% | 3 | Lehman Brothers | 9 | Yes | No |
| 21/03/1997 | Cell Therapeutics Inc | 2% | 260% | -121% | 17 | UBS Securities Inc | 8 | Yes | No |
| 30/07/2014 | Catalent Inc | 0% | 44% | 52% | 12 | Deutsche Bank Securities Inc | 8 | No | Yes |
| 07/10/2015 | CytomX Therapeutics Inc | 7% | -30% | -72% | 4 | Cowen & Co | 8 | Yes | No |
| 15/10/2004 | CoTherix Inc | 0% | 127% | 73% | 4 | CIBC World Markets Inc | 8 | Yes | No |
| 19/11/1996 | CV Therapeutics Inc | -7% | 151% | 75% | 3 | JP Morgan & Co Inc | 9 | Yes | No |
| 18/06/2015 | Celyad SA | -20% | -28% | -95% | 2 | UBS Investment Bank | 9 | No | No |
| 29/04/2004 | Cytokinetics Inc | 24% | -63% | -90% | 4 | Goldman Sachs & Co | 9 | Yes | No |
| 28/09/1995 | DepoTech Corp | 17% | -144% | -161% | 1 | Dillon, Read & Co Inc | 7 | Yes | No |
| 03/10/14 | Dermira Inc | -3% | 27% | 5% | 1 | Volpe Welty & Co | 7 | Yes | No |

| | | | | | | | | | |
|------------|--------------------------------|------|-------|-------|---|--|---|-----|-----|
| 02/08/2000 | Deltagen Inc | 23% | -182% | -44% | 5 | Salomon Smith Barney | 9 | Yes | No |
| 22/05/1996 | Digene Corp | 1% | 23% | -89% | 2 | UBS Securities Inc | 8 | Yes | No |
| 21/10/2015 | Dimension Therapeutics Inc | -18% | 27% | -92% | 6 | Goldman Sachs & Co | 9 | Yes | No |
| 19/07/1999 | Genentech Inc | 36% | 85% | 32% | 5 | JP Morgan & Co Inc | 9 | No | No |
| 15/07/2015 | ProNAi Therapeutics Inc | 79% | -196% | -164% | 4 | Wedbush Securities | 8 | Yes | No |
| 16/06/2000 | Dendreon Corp | -3% | 148% | -9% | 3 | Prudential Vector Healthcare | 4 | Yes | No |
| 27/07/2000 | Discovery Partners | 10% | 68% | -20% | 3 | Chase H&Q | 7 | Yes | No |
| 12/03/2014 | Dipexim Pharmaceuticals LLC | 19% | -92% | -136% | 2 | Oppenheimer & Co Inc | 8 | No | No |
| 27/09/2000 | DURECT Corp | 16% | -4% | -42% | 3 | Morgan Stanley Dean Witter & Co | 8 | Yes | No |
| 18/07/2012 | Durata Therapeutics Inc | 0% | 112% | 129% | 5 | Bank of America Merrill Lynch | 9 | Yes | No |
| 19/02/2004 | Dynavax Technologies Corp | 25% | 21% | -50% | 3 | Bear Stearns & Co Inc | 9 | Yes | No |
| 14/08/2000 | Dyax Corp | 72% | 34% | -35% | 3 | JP Morgan & Co Inc | 9 | Yes | No |
| 05/08/2014 | Auris Medical Holding AG | 0% | -147% | -130% | 4 | Jefferies & Co Inc | 8 | Yes | No |
| 05/02/2014 | Eleven Biotherapeutics Inc | 7% | 162% | -127% | 3 | Citigroup Global Markets Inc | 8 | Yes | No |
| 14/11/2006 | Emergent BioSolutions Inc | -7% | 98% | 28% | 3 | JP Morgan & Co Inc | 9 | Yes | No |
| 04/02/2011 | Endocyte Inc | 29% | 164% | 127% | 5 | RBC Capital Markets | 9 | Yes | No |
| 30/09/2015 | Edge Therapeutics Inc | 17% | -145% | -139% | 4 | Credit Suisse Securities (USA) LLC | 8 | Yes | No |
| 02/02/2016 | Editas Medicine Inc | 14% | -29% | -88% | 4 | JP Morgan & Co Inc | 9 | Yes | No |
| 05/08/1997 | Eagle Geophysical Inc | 11% | -249% | -159% | 2 | Prudential Securities Inc | 9 | No | No |
| 05/02/2014 | Egalet Corp | -1% | -18% | -104% | 4 | Banc of America Securities LLC | 8 | Yes | No |
| 11/02/2014 | Eagle | -15% | 248% | 510% | 3 | William Blair & Co | 8 | Yes | No |
| 11/06/1996 | EntreMed Inc | 5% | 137% | -23% | 4 | Allen & Co Inc | 8 | Yes | No |
| 24/10/1996 | Enamelon Inc | 0% | -79% | -190% | 2 | Rodman & Renshaw Inc | 5 | No | No |
| 20/03/2013 | Enanta Pharmaceuticals Inc | 24% | 31% | 3% | 4 | JP Morgan & Co Inc | 9 | Yes | No |
| 30/01/1997 | EPIX Medical Inc | 2% | 42% | -130% | 2 | Hambrecht & Quist Inc | 8 | Yes | No |
| 30/05/2013 | Epizyme Inc | 55% | -46% | -106% | 6 | Cowen & Co | 8 | Yes | No |
| 14/12/1995 | Ergo Science Corp | 11% | -236% | -231% | 2 | Cowen & Co | 8 | Yes | No |
| 16/05/2007 | Eurand NV | -3% | 9% | -19% | 5 | Banc of America Securities LLC | 8 | No | Yes |
| 20/11/2013 | Evogene Ltd | 15% | -145% | -103% | 4 | Credit Suisse | 9 | No | No |

| | | | | | | | | | |
|------------|-------------------------------|------|-------|-------|---|--|---|-----|-----|
| 24/09/2013 | Evoke Pharma Inc | -2% | -133% | -118% | 6 | Fleet Boston Corp, Boston, Massachusetts | 7 | Yes | No |
| 30/01/2001 | Exact Sciences Corp | 8% | 65% | -27% | 3 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 10/04/2000 | Exelixis Inc | 21% | 76% | -14% | 3 | Goldman Sachs & Co | 9 | Yes | No |
| 30/07/2015 | Eyegate Pharmaceuticals Inc | -16% | -106% | -155% | 2 | Aegis Capital Corp. | 7 | No | No |
| 29/01/2004 | Eyeteq Pharmaceuticals Inc | 54% | -36% | -56% | 4 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 30/09/2013 | Fate Therapeutics Inc | 9% | -30% | -79% | 4 | Cowen & Co | 8 | Yes | No |
| 13/11/2014 | FibroGen Inc | 22% | 68% | 28% | 6 | Goldman Sachs & Co | 9 | Yes | No |
| 28/01/2015 | Flex Pharma Inc | -7% | -110% | -123% | 5 | Piper Jaffray Cos | 8 | Yes | No |
| 11/02/2014 | Flexion Therapeutics Inc | 13% | 90% | 23% | 4 | Wells Fargo Securities LLC | 8 | Yes | No |
| 30/05/2007 | Amicus Therapeutics Inc | -4% | -69% | -62% | 5 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 17/09/2014 | Foamix Pharmaceuticals Ltd | 3% | 29% | -32% | 4 | Barclays | 8 | No | No |
| 18/09/2013 | Five Prime Therapeutics Inc | 1% | 210% | 265% | 4 | BMO Capital Markets | 7 | Yes | No |
| 02/02/2005 | Faville Inc | -3% | -77% | -83% | 4 | Piper Jaffray | 7 | Yes | No |
| 14/10/2014 | Forward Pharma A/S | -16% | 36% | -44% | 4 | Leerink Partners LLC | 7 | Yes | No |
| 01/07/2014 | Globelmmune Inc | 11% | -35% | -87% | 1 | Aegis Capital Corp. | 7 | Yes | No |
| 11/08/2015 | Global Blood Therapeutics Inc | 115% | 26% | -84% | 5 | Morgan Stanley & Co | 9 | Yes | No |
| 27/07/2000 | Genencor International Inc | 26% | 49% | 10% | 4 | Merrill Lynch & Co Inc | 9 | No | No |
| 05/08/2016 | Gemphire Therapeutics Inc | -8% | -161% | -147% | 6 | Laidlaw & Co (UK) Ltd | 5 | No | Yes |
| 05/06/1996 | Genset SA | 33% | -89% | -185% | 5 | CS First Boston Corp | 9 | No | No |
| 30/07/1996 | Geron Corp | -4% | 44% | -83% | 3 | JP Morgan & Co Inc | 9 | Yes | No |
| 27/03/1996 | GalaGen Inc | 0% | -134% | -193% | 2 | Montgomery Securities | 8 | Yes | No |
| 03/10/2001 | Given Imaging Ltd | 3% | 104% | 120% | 6 | Credit Suisse First Boston Corp | 8 | Yes | No |
| 17/06/1994 | Guilford Pharmaceuticals Inc | 3% | 160% | 183% | 2 | Blech (D.) & Company, Incorporated | 5 | No | No |
| 21/11/1997 | Gene Logic Inc | 0% | 408% | 72% | 3 | BancAmerica Robertson Stephens Inc | 7 | Yes | No |
| 19/10/1995 | Gliatech Inc | 0% | 101% | 76% | 3 | Montgomery Securities | 8 | Yes | No |
| 12/03/2014 | Galmed Pharmaceuticals Ltd | 8% | -15% | -83% | 3 | MLV & Co | 4 | No | No |
| 13/05/2015 | Galapagos NV | 18% | 52% | 28% | 3 | MORGAN STANLEY | 9 | No | No |
| 09/01/14 | GlycoMimetics Inc | -13% | -47% | -85% | 4 | Barclays PLC | 7 | Yes | No |
| 04/02/2014 | Genocea Biosciences Inc | -8% | -16% | -107% | 4 | Cowen & Co | 8 | Yes | No |

| | | | | | | | | | |
|------------|-------------------------------|------|-------|-------|----|--------------------------------|---|-----|-----|
| 10/11/2010 | Complete Genomics Inc | -10% | -45% | -77% | 4 | Robert W Baird & Co Inc | 8 | Yes | No |
| 11/12/2000 | GenVec Inc | 7% | 76% | -26% | 3 | JP Morgan & Co Inc | 9 | Yes | No |
| 29/10/2003 | Genitope Corp | 11% | -84% | -95% | 3 | WR Hambrecht & Co LLC | 7 | Yes | No |
| 02/02/2004 | GTx Inc | -11% | 85% | 75% | 3 | Goldman Sachs & Co | 9 | Yes | No |
| 09/07/1993 | Genzyme Transgenics Corp | 2% | 37% | -70% | 2 | PaineWebber Inc | 9 | No | No |
| 17/03/2016 | Hutchison China MediTech Ltd | -1% | 67% | 60% | 2 | Stifel Nicolaus & Co Inc | 8 | No | No |
| 23/05/2007 | Helicos BioSciences Corp | -4% | 143% | -76% | 4 | UBS Investment Bank | 9 | Yes | No |
| 25/07/2012 | Hyperion Therapeutics Inc | 0% | 151% | 284% | 3 | Cowen & Co | 8 | Yes | No |
| 30/06/1997 | Heska Corp | 2% | -69% | -223% | 2 | CS First Boston Corp | 9 | Yes | No |
| 23/07/2013 | Heat Biologics Inc | -4% | -121% | -131% | 2 | Aegis Capital Corp. | 7 | Yes | No |
| 07/08/1997 | Hyseq Inc | 8% | 273% | -34% | 3 | Lehman Brothers | 9 | No | No |
| 28/07/2011 | Horizon Pharma Inc | 2% | 89% | -49% | 3 | Cowen & Co | 8 | Yes | No |
| 24/07/2013 | Cellular Dynamics Intl Inc | -21% | 118% | -11% | 2 | Robinson-Humphrey Co | 7 | Yes | No |
| 03/02/2005 | Icagen Inc | -9% | -26% | -89% | 3 | UBS Investment Bank | 9 | Yes | No |
| 10/10/2012 | Intercept Pharmaceuticals Inc | 29% | 416% | 586% | 7 | Bank of America Merrill Lynch | 9 | Yes | No |
| 21/07/2004 | Idenix Pharmaceuticals Inc | -5% | -128% | -120% | 3 | Goldman Sachs & Co | 9 | Yes | No |
| 23/07/2014 | Immune Design Corp | 0% | 59% | -50% | 3 | Leerink Partners LLC | 7 | Yes | No |
| 07/02/2013 | Imprimis Pharmaceuticals Inc | -7% | 23% | -82% | 1 | MDB Capital Group LLC | 1 | No | No |
| 25/07/2007 | ImaRx Therapeutics Inc | -2% | -253% | -79% | 3 | Maxim Group LLC | 7 | Yes | No |
| 11/10/2000 | Introgen Therapeutics Inc | 9% | 96% | -3% | 4 | SG Cowen Securities Corp | 8 | Yes | No |
| 03/06/2004 | Inhibitex Inc | 2% | -105% | -115% | 3 | Thomas Weisel Partners | 8 | Yes | No |
| 25/07/2014 | Innocoll AG | 0% | -2% | -107% | 3 | Stifel Nicolaus & Co Inc | 8 | No | Yes |
| 01/02/2006 | Iomai Corp | -3% | 142% | 14% | 4 | UBS Investment Bank | 9 | Yes | No |
| 23/04/1998 | Iomed Inc | -3% | 6% | -70% | 3 | EVEREN Securities Inc | 6 | No | Yes |
| 27/06/2002 | Inveresk Research Group Inc | 0% | 84% | 125% | 4 | Bear Stearns & Co Inc | 9 | No | Yes |
| 02/02/2010 | Ironwood Pharmaceuticals Inc | 4% | 13% | -2% | 5 | Credit Suisse | 9 | Yes | No |
| 02/08/2000 | Inspire Pharmaceuticals Inc | 22% | 220% | 9% | 18 | Banc of America Securities LLC | 8 | Yes | No |
| 21/08/2000 | ISTA Pharmaceuticals Inc | 2% | -9% | -43% | 3 | CIBC World Markets Inc | 8 | Yes | No |
| 30/01/2014 | Intra-Cellular Therapies Inc | 11% | 25% | -55% | 3 | J.P. Morgan | 4 | No | No |

| | | | | | | | | | |
|------------|-----------------------------------|------|-------|-------|----|---------------------------------------|---|-----|-----|
| 17/02/2015 | Inotek Pharms Corp | 0% | 187% | -58% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 24/03/2000 | Intermune Pharmaceuticals Inc | 25% | 200% | 80% | 3 | Warburg Dillon Read Inc | 6 | Yes | No |
| 01/02/1996 | Intercardia Inc | 38% | -39% | -192% | 2 | Montgomery Securities | 8 | No | No |
| 26/02/1999 | Invitrogen Corp | 2% | 221% | 192% | 3 | Donaldson Lufkin & Jenrette Inc | 9 | Yes | No |
| 13/05/2015 | Jaguar Animal Health Inc | -3% | -318% | -149% | 3 | Aegis Capital Corp. | 7 | Yes | No |
| 31/05/2007 | Jazz Pharmaceuticals Inc | -2% | 235% | -27% | 4 | Lehman Brothers | 9 | No | Yes |
| 18/12/2014 | Juno Therapeutics Inc | 45% | 116% | 41% | 5 | Morgan Stanley | 9 | Yes | No |
| 31/01/2013 | KaloBios Pharmaceuticals Inc | 0% | -254% | -156% | 3 | Leerink Swann & Co | 7 | Yes | No |
| 26/07/2016 | Kadmon Holdings LLC | -20% | -106% | -131% | 4 | JMP Securities LLC | 8 | No | No |
| 11/12/2013 | Kindred Biosciences Inc | 71% | -63% | -95% | 3 | BMO Capital Markets | 7 | No | No |
| 19/06/2014 | Kite Pharma Inc | 70% | 172% | 316% | 4 | Cowen & Co | 8 | Yes | No |
| 30/05/2013 | Kamada Ltd | 10% | -111% | -109% | 5 | Cantor Fitzgerald & Co. | 3 | No | Yes |
| 15/04/2015 | KemPharm Inc | 2% | -7% | -96% | 4 | Cowen & Co | 8 | Yes | No |
| 22/08/1997 | Kendle International Inc | 14% | -136% | -173% | 2 | Lehman Brothers | 9 | No | No |
| 05/10/2000 | Kosan Biosciences Inc | 0% | 55% | -1% | 4 | Lehman Brothers | 9 | Yes | No |
| 05/11/2013 | Karyopharm Therapeutics Inc | 1% | 9% | -88% | 4 | Leerink Swann & Co | 7 | Yes | No |
| 10/10/2012 | KYTHERA Biopharmaceuticals Inc | 24% | 115% | 153% | 4 | Lazard Capital Markets | 7 | Yes | No |
| 07/04/2000 | Lexicon Genetics Inc | -15% | 232% | 10% | 4 | JP Morgan & Co Inc | 9 | Yes | No |
| 15/08/1997 | LeukoSite Inc | 0% | 139% | 218% | 13 | BT Alex Brown Inc | 8 | Yes | No |
| 31/07/2014 | Loxo Oncology Inc | 0% | 235% | 557% | 4 | Cowen & Co | 8 | Yes | No |
| 02/06/2006 | Luna Innovations Inc | 0% | -130% | -87% | 3 | ThinkEquity Partners | 6 | Yes | No |
| 28/03/2012 | Merrimack Pharmaceuticals Inc | -13% | 67% | -22% | 4 | JP Morgan & Co Inc | 9 | Yes | No |
| 04/10/2007 | MAP Pharmaceuticals Inc | 9% | 352% | 13% | 3 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 23/11/1993 | Martek Biosciences Corp | 0% | 72% | 56% | 4 | Citigroup | 9 | Yes | No |
| 15/12/1999 | Maxygen Inc | 156% | -29% | -24% | 3 | Goldman Sachs & Co | 9 | Yes | No |
| 15/06/2004 | Metabasis Therapeutics Inc | -5% | -6% | -77% | 2 | SG Cowen Securities Corp | 8 | Yes | No |
| 02/05/2016 | Moleculin Biotech Inc | 29% | -86% | -143% | 2 | Bonwick Capital Partners LLC | 1 | No | No |
| 14/05/1996 | Microcide Pharmaceuticals Inc | 32% | -145% | -190% | 3 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 26/10/2000 | MediChem Life Sciences Inc | 10% | 87% | -31% | 3 | UBS Warburg | 8 | Yes | No |

| | | | | | | | | | |
|------------|-----------------------------------|------|-------|-------|---|--|---|-----|-----|
| 25/06/2015 | Seres Therapeutics Inc | 187% | -132% | -130% | 4 | Merrill Lynch Pierce Fenner & Smith | 8 | Yes | No |
| 30/07/2014 | Macrocure Ltd | -26% | -73% | -103% | 4 | Jefferies & Co Inc | 8 | Yes | No |
| 07/08/2000 | The Medicines Co | 36% | 137% | 27% | 5 | JP Morgan & Co Inc | 9 | Yes | No |
| 19/03/2014 | MediWound Ltd | 23% | -57% | -88% | 4 | BMO Capital Markets | 7 | Yes | No |
| 20/06/1991 | Medarex Inc | 0% | 13% | -57% | 4 | Rosenkrantz, Ehrenkrantz, Lyon & Ross, Incorporated | 4 | Yes | No |
| 05/04/2004 | Memory Pharmaceuticals Corp | 20% | 9% | -90% | 4 | UBS Investment Bank | 9 | Yes | No |
| 09/10/2013 | MacroGenics Inc | 53% | 32% | -33% | 6 | Bank of America Merrill Lynch | 9 | Yes | No |
| 01/02/2007 | Molecular Insight Pharm Inc | 0% | -100% | -88% | 4 | RBC Capital Markets | 9 | Yes | No |
| 30/09/2015 | Mirna Therapeutics Inc | 1% | -101% | -122% | 4 | Leerink Partners LLC | 7 | Yes | No |
| 06/05/1996 | Millennium Pharmaceuticals Inc | 59% | 55% | 6% | 2 | Goldman Sachs & Co | 9 | Yes | No |
| 28/07/2004 | MannKind Corp | 1% | -23% | -78% | 5 | UBS Investment Bank | 9 | Yes | No |
| 21/06/2004 | Momenta Pharmaceuticals Inc | 19% | 58% | -17% | 4 | SG Cowen Securities Corp | 8 | Yes | No |
| 31/07/2014 | Marinus Pharmaceuticals Inc | 0% | 40% | -102% | 4 | JMP Securities LLC | 8 | Yes | No |
| 18/05/2016 | Merus BV | 56% | 81% | 18% | 4 | Wedbush Securities | 8 | Yes | No |
| 18/12/2003 | Marshall Edwards Inc | 0% | -72% | -82% | 1 | Janney Montgomery Scott LLC | 7 | No | No |
| 28/10/2015 | MyoKardia Inc | 6% | 255% | 358% | 5 | Cowen & Co | 8 | Yes | No |
| 23/05/1996 | Neurocrine Biosciences Inc | 19% | -82% | -168% | 3 | Robertson Stephens & Co | 8 | Yes | No |
| 17/09/2015 | Nabriva Therapeutics | 31% | -169% | -125% | 5 | Wedbush Securities, Inc. | 6 | Yes | No |
| 21/12/2005 | NUCRYST Pharmaceuticals Corp | 0% | -119% | -53% | 4 | Jefferies & Co Inc | 8 | No | No |
| 13/11/2014 | Neuroderm Ltd | -9% | 118% | 140% | 4 | Roth Capital Partners Inc | 6 | Yes | No |
| 22/07/2015 | Neos Therapeutics Inc | 31% | -154% | -148% | 4 | BMO Capital Markets | 7 | Yes | No |
| 26/09/1996 | NeoTherapeutics Inc | -28% | 83% | 8% | 3 | Needham & Co LLC | 8 | No | No |
| 30/06/2014 | Minerva Neurosciences Inc | 0% | 9% | -55% | 3 | Jefferies LLC | 7 | No | Yes |
| 01/05/2007 | Neurogesx Inc | -8% | 118% | -3% | 4 | Morgan Stanley | 9 | Yes | No |
| 27/07/2015 | NantKwest Inc | 37% | -115% | -150% | 5 | Citigroup Global Markets Inc | 8 | No | No |
| 09/12/2009 | China Nuokang Bio-Pharm Inc | -4% | -27% | -67% | 2 | Jefferies & Co Inc | 8 | Yes | No |
| 10/11/2011 | NewLink Genetics Corp | -1% | 190% | 383% | 4 | Stifel Nicolaus & Co Inc | 8 | Yes | No |
| 09/05/2006 | Novacea Inc | 1% | -84% | -73% | 4 | Cowen & Co | 8 | Yes | No |
| 20/09/2016 | Novan Inc | 63% | -60% | -149% | 4 | JMP Securities LLC | 8 | No | No |

| | | | | | | | | | |
|------------|-------------------------------|------|-------|-------|---|--|---|-----|-----|
| 25/01/1996 | Neopharm Inc | -23% | 160% | 105% | 1 | National Securities Corp (US) | 7 | No | No |
| 10/10/1997 | National Research Corp | 47% | -156% | -144% | 2 | William Blair & Co | 8 | No | No |
| 05/08/2004 | New River Pharmaceuticals Inc | -6% | 291% | 1158% | 4 | WR Hambrecht & Co LLC | 7 | No | Yes |
| 11/02/2014 | NephroGenex Inc | -4% | -156% | -108% | 1 | Aegis Capital Corp. | 7 | Yes | No |
| 15/02/1996 | Neose Technologies Inc | 7% | -69% | -149% | 2 | Smith Barney Incorporated | 8 | Yes | No |
| 05/05/2016 | Intellia Therapeutics Inc | 22% | -10% | -89% | 3 | Credit Suisse Securities (USA) LLC | 8 | Yes | No |
| 05/11/2003 | NitroMed Inc | -16% | 18% | -86% | 3 | Deutsche Bank Securities Corp. | 8 | Yes | No |
| 22/07/1998 | Natrol Inc | 13% | -17% | -71% | 3 | Adams Harkness & Hill Inc | 7 | Yes | No |
| 19/02/1998 | Nutraceutical International | 11% | -227% | -91% | 2 | Donaldson Lufkin & Jenrette Inc | 9 | No | Yes |
| 04/02/2015 | Nexvet Biopharma plc | -12% | 21% | -42% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 16/06/2015 | Nivalis Therapeutics Inc | 6% | -178% | -139% | 4 | Stifel Nicolaus & Co Inc | 8 | Yes | No |
| 24/07/2014 | Ocular Therapeutix Inc | 2% | -2% | -102% | 4 | RBC Capital Markets | 9 | Yes | No |
| 17/07/2013 | OncoMed Pharmaceuticals Inc | 60% | 5% | -84% | 4 | Jefferies & Co Inc | 8 | Yes | No |
| 07/10/2009 | Omeros Corp | -13% | 15% | -31% | 7 | Deutsche Bank Securities Corp. | 8 | Yes | No |
| 13/12/2006 | Obagi Medical Products Inc | -9% | 25% | -7% | 4 | JP Morgan & Co Inc | 9 | No | Yes |
| 20/04/2006 | Omrix Biopharmaceuticals Inc | 1% | 143% | 114% | 4 | UBS Investment Bank | 9 | Yes | No |
| 29/01/2015 | Spark Therapeutics Inc | 120% | 23% | -47% | 4 | JP Morgan & Co Inc | 9 | Yes | No |
| 24/07/2013 | Onconova Therapeutics Inc | 32% | -360% | -144% | 4 | Leerink Swann & Co | 7 | Yes | No |
| 09/05/1996 | Onyx Pharmaceuticals Inc | -5% | -11% | -116% | 2 | Montgomery Securities | 8 | Yes | No |
| 07/05/1998 | Ophidian Pharmaceuticals Inc | -22% | 32% | -177% | 6 | Kashner Davidson Securities | 2 | No | No |
| 09/03/2000 | OraPharma Inc | -42% | 170% | 38% | 5 | Fleet Boston Corp, Boston, Massachusetts | 7 | Yes | No |
| 24/09/2013 | Ophthotech Corp | 20% | 18% | -26% | 4 | JP Morgan & Co Inc | 9 | Yes | No |
| 09/02/2007 | Optimer Pharmaceuticals Inc | 21% | 90% | 27% | 4 | Jefferies & Co Inc | 8 | Yes | No |
| 04/05/2000 | Orchid BioSciences Inc | 33% | -63% | -38% | 5 | Credit Suisse First Boston Corp | 8 | Yes | No |
| 25/04/2007 | Orexigen Therapeutics Inc | 8% | -16% | -56% | 2 | Montgomery Securities | 8 | Yes | No |
| 30/07/2014 | Bio Blast Pharma Ltd | -22% | -254% | -134% | 3 | Roth Capital Partners Inc | 6 | Yes | No |
| 08/06/1995 | Oravax Inc | -9% | -251% | -180% | 2 | Donaldson Lufkin & Jenrette Inc | 9 | Yes | No |
| 03/08/2006 | Osiris Therapeutics Inc | 0% | 51% | -27% | 3 | Jefferies & Co Inc | 8 | No | Yes |
| 12/08/2014 | Otonomy Inc | 6% | -90% | -131% | 1 | Texas Capital Securities Inc | 5 | Yes | No |

| | | | | | | | | | |
|------------|-------------------------------|-------|-------|-------|----|---------------------------------|---|-----|-----|
| 21/11/2013 | Oxford Immunotec Global PLC | 28% | -36% | -52% | 1 | Prudential Securities Inc | 9 | Yes | No |
| 10/04/2014 | Phibro Animal Health Corp | 15% | 51% | 47% | 3 | Morgan Stanley & Co | 9 | No | No |
| 18/06/2014 | Parnell Pharm Hldg Ltd | -20% | -196% | -112% | 5 | JMP Securities LLC | 8 | No | No |
| 05/08/2010 | NuPathe Inc | -4% | -92% | -126% | 4 | Donaldson Lufkin & Jenrette Inc | 9 | Yes | No |
| 09/02/2005 | Prestige Brands Holdings Inc | 11% | -65% | -68% | 6 | Merrill Lynch & Co Inc | 9 | No | Yes |
| 18/10/2012 | Puma Biotechnology Inc | 43% | 277% | 196% | 5 | Bank of America Merrill Lynch | 9 | No | No |
| 02/02/2011 | Pacira Pharmaceuticals Inc | 0% | 242% | 835% | 5 | Barclays | 8 | Yes | No |
| 23/10/1995 | Pharmacyclics Inc | 0% | -5% | -71% | 2 | CS First Boston Corp | 9 | Yes | No |
| 05/05/2000 | Paradigm Genetics Inc | 2% | 24% | -29% | 4 | Chase H&Q | 7 | Yes | No |
| 26/06/2013 | Aratana Therapeutics Inc | 37% | 59% | -61% | 6 | Stifel Nicolaus & Co Inc | 8 | Yes | No |
| 23/07/2014 | Pfenex Inc | -12% | -6% | -84% | 3 | JMP Securities LLC | 8 | Yes | No |
| 19/11/1997 | Progenics Pharmaceuticals Inc | 1% | 120% | -34% | 3 | CIBC | 6 | Yes | No |
| 05/11/2003 | Pharmion Corp | -100% | 79% | 48% | 4 | Oppenheimer Morgan Stanley | 9 | Yes | No |
| 10/10/2000 | Pozen Inc | 4% | 157% | 5% | 3 | US Bancorp Piper Jaffray Inc | 7 | Yes | No |
| 24/01/1996 | Pharmaceutical Prod Dvlp Inc | 42% | -28% | -80% | 2 | Lehman Brothers | 9 | No | No |
| 12/11/2014 | PRA Health Sciences Inc | 9% | 110% | 230% | 8 | UBS Securities Inc | 8 | No | Yes |
| 17/11/2004 | PRA International | 10% | -3% | 0% | 1 | Tucker Anthony Inc | 7 | No | Yes |
| 26/04/2000 | Praecis Pharmaceuticals Inc | 6% | 80% | -16% | 3 | Salomon Smith Barney | 9 | Yes | No |
| 18/09/2014 | ProQR Therapeutics BV | 13% | -109% | -116% | 4 | JMP Securities LLC | 8 | Yes | No |
| 21/10/2014 | Proteon Therapeutics Inc | 1% | -58% | -127% | 4 | JMP Securities LLC | 8 | Yes | No |
| 19/06/2013 | PTC Therapeutics Inc | 13% | -27% | -104% | 3 | J.P. Morgan | 4 | Yes | No |
| 10/08/2016 | Protagonist Therapeutics Inc | -3% | -21% | -94% | 3 | Leerink Partners LLC | 7 | Yes | No |
| 20/07/2016 | Patheon N.V. | 19% | 8% | 2% | 13 | Jefferies & Co Inc | 8 | No | Yes |
| 11/02/2016 | Proteostasis Therapeutics Inc | -17% | 69% | -146% | 3 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 13/07/2000 | Pain Therapeutics Inc | 79% | 102% | -3% | 3 | Thomas Weisel Partners | 8 | Yes | No |
| 21/05/2013 | Portola Pharmaceuticals Inc | 6% | -4% | -46% | 5 | Credit Suisse | 9 | Yes | No |
| 17/05/2016 | PhaseRx Inc | 0% | -201% | -146% | 2 | Laidlaw & Co (UK) Ltd | 5 | Yes | No |
| 08/05/2013 | Quintiles Transnatl Hldg Inc | 5% | 10% | 11% | 16 | Raymond James & Associates Inc | 9 | No | Yes |
| 05/02/2014 | uniQure BV | -14% | -59% | -104% | 3 | Leerink Swann & Co | 7 | Yes | No |

| | | | | | | | | | |
|------------|----------------------------------|------|-------|-------|---|---------------------------------------|---|-----|-----|
| 30/01/2014 | Ultragenyx Pharmaceutical Inc | 102% | 78% | 17% | 1 | Tucker Anthony Inc | 7 | Yes | No |
| 25/10/2016 | Ra Pharmaceuticals Inc | 1% | 170% | 194% | 4 | SunTrust Robinson Humphrey | 7 | Yes | No |
| 08/05/2013 | Receptos Inc | 0% | 277% | 995% | 5 | Leerink Swann & Co | 7 | Yes | No |
| 05/06/2014 | Radius Health Inc | 0% | 223% | 348% | 2 | Jefferies LLC | 7 | Yes | No |
| 06/03/2014 | Recro Pharma Inc | 4% | 103% | -25% | 2 | Aegis Capital Corp. | 7 | Yes | No |
| 25/05/2016 | Reata Pharmaceuticals Inc | 19% | 195% | 312% | 3 | Piper Jaffray | 7 | Yes | No |
| 04/06/2007 | Response Genetics Inc | 0% | 27% | -40% | 2 | Maxim Group LLC | 7 | No | No |
| 16/09/2015 | Regenbio Inc | 38% | 171% | 287% | 4 | Morgan Stanley & Co | 9 | Yes | No |
| 28/11/2000 | Rigel Pharmaceuticals Inc | 3% | -17% | -60% | 5 | Morgan Stanley Dean Witter & Co | 8 | Yes | No |
| 14/11/2013 | Relypsa Inc | 9% | 80% | 3% | 6 | Morgan Stanley | 9 | Yes | No |
| 12/04/2002 | Ribapharm Inc | 8% | -38% | -56% | 7 | UBS Warburg | 8 | No | No |
| 27/06/2013 | Prosensa Holding BV | 48% | 37% | -67% | 7 | JP Morgan & Co Inc | 9 | Yes | No |
| 04/02/2004 | Renovis Inc | 21% | -8% | -87% | 4 | Goldman Sachs & Co | 9 | Yes | No |
| 26/02/2007 | Rosetta Genomics Ltd | 9% | -3% | -67% | 2 | CE Unterberg Towbin | 6 | Yes | No |
| 03/08/2000 | Rosetta Inpharmatics Inc | 28% | 34% | -3% | 4 | Lehman Brothers | 9 | Yes | No |
| 10/08/2000 | Regeneration Technologies Inc | 0% | 145% | 60% | 3 | Banc of America Securities LLC | 8 | Yes | No |
| 10/01/2014 | Retrophin Inc | 35% | 59% | -15% | 2 | Leerink Partners | 5 | No | No |
| 24/06/2015 | Ritter Pharmaceuticals Inc | -1% | -225% | -144% | 3 | Aegis Capital Corp. | 7 | Yes | No |
| 05/02/2014 | Revice Therapeutics Inc | 66% | -22% | -75% | 3 | Piper Jaffray Cos | 8 | Yes | No |
| 13/03/2014 | Ignyta Inc | 12% | 66% | -31% | 2 | Leerink Swann & Co | 7 | No | No |
| 11/04/1996 | Ribozyme Pharmaceuticals Inc | 0% | -129% | -170% | 2 | Montgomery Securities | 8 | Yes | No |
| 17/07/2014 | SAGE Therapeutics Inc | 65% | 126% | 144% | 1 | JP Morgan & Co Inc | 9 | Yes | No |
| 05/05/2016 | Spring Bk Pharms Inc | -8% | -94% | -126% | 1 | Dawson James Securities | 5 | No | No |
| 02/08/2007 | Sucampo Pharmaceuticals Inc | 7% | -23% | -53% | 3 | Cowen & Co | 8 | Yes | No |
| 19/04/2007 | Simcere Pharmaceutical Group | 5% | -23% | -33% | 4 | Goldman Sachs (Asia) | 3 | No | Yes |
| 01/05/2014 | SCYNEXIS Inc | -10% | -123% | -117% | 3 | RBC Capital Markets | 9 | Yes | No |
| 21/06/2016 | Selecta Biosciences Inc | 0% | -100% | -142% | 4 | Needham & Co LLC | 8 | Yes | No |
| 06/03/2001 | Seattle Genetics Inc | 17% | 57% | 12% | 3 | JP Morgan & Co Inc | 9 | Yes | No |
| 06/04/2000 | Sangamo BioSciences Inc | 0% | 342% | 10% | 4 | Lehman Brothers | 9 | Yes | No |

| | | | | | | | | | |
|------------|-------------------------------|------|-------|-------|---|---------------------------------|---|-----|-----|
| 19/04/2011 | Sagent Pharmaceuticals Inc | 22% | -24% | -60% | 3 | Donaldson Lufkin & Jenrette Inc | 9 | Yes | No |
| 31/01/2006 | SGX Pharmaceuticals Inc | 0% | 8% | -68% | 4 | Piper Jaffray Cos | 8 | Yes | No |
| 08/04/1998 | Schein Pharmaceutical Inc | 43% | -12% | -124% | 4 | Cowen & Co | 8 | No | No |
| 18/10/10 | ShangPharma Corp | -13% | -41% | -55% | 4 | William Blair & Co | 8 | No | Yes |
| 09/05/1996 | SIBIA Neurosciences Inc | -2% | -93% | -167% | 3 | Salomon Brothers Inc | 8 | No | No |
| 22/05/2007 | Sirtris Pharmaceuticals Inc | 8% | 116% | 131% | 5 | JP Morgan & Co Inc | 9 | Yes | No |
| 02/03/2016 | Syndax Pharmaceuticals Inc | 0% | -23% | -117% | 4 | JMP Securities LLC | 8 | Yes | No |
| 21/06/2004 | Senomyx Inc | 11% | 70% | 49% | 4 | Citigroup | 9 | Yes | No |
| 27/09/2005 | Sunesis Pharmaceuticals Inc | -7% | -151% | -68% | 3 | SG Cowen Securities Corp | 8 | Yes | No |
| 06/02/2007 | Synta Pharmaceuticals Corp | -9% | 127% | -46% | 4 | Lehman Brothers | 9 | Yes | No |
| 31/03/2004 | Santarus Inc | 11% | -61% | -89% | 4 | SG Cowen Securities Corp | 8 | Yes | No |
| 12/10/1995 | Sonus Pharmaceuticals Inc | -2% | -20% | -111% | 3 | Hambrecht & Quist Inc | 8 | Yes | No |
| 14/12/2005 | Somaxon Pharmaceuticals Inc | -3% | -31% | -51% | 4 | JP Morgan & Co Inc | 9 | Yes | No |
| 06/02/2007 | 3SBio Inc | -8% | 78% | 13% | 3 | CIBC World Markets Inc | 8 | No | Yes |
| 19/03/2015 | SteadyMed Ltd | 0% | -23% | -94% | 3 | JMP Securities LLC | 8 | Yes | No |
| 28/01/2013 | Stemline Therapeutics Inc | 18% | -76% | -104% | 3 | Aegis Capital Corp. | 7 | No | No |
| 12/03/1996 | Supergen Inc | -30% | -26% | -114% | 1 | Paulson Investment Co | 6 | No | No |
| 30/04/2012 | Supernus Pharmaceuticals Inc | 7% | 39% | 12% | 4 | Citi | 9 | Yes | No |
| 29/06/2016 | Syros Pharmaceuticals Inc | 43% | -17% | -94% | 5 | Piper Jaffray Cos | 8 | Yes | No |
| 09/10/2007 | Targanta Therapeutics Corp | -6% | 199% | -29% | 4 | Credit Suisse | 9 | Yes | No |
| 24/01/2011 | Tibet Pharmaceuticals Inc | 2% | -76% | -82% | 2 | Anderson & Strudwick | 4 | No | No |
| 18/07/2000 | Transgenomic Inc | 60% | -80% | -37% | 3 | Chase H&Q | 7 | Yes | No |
| 15/03/2007 | Tongjitang Chinese Medicines | -2% | -44% | -56% | 3 | UBS Investment Bank | 9 | Yes | No |
| 29/01/2015 | TRACON Pharmaceuticals Inc | -5% | -184% | -130% | 4 | Stifel Nicolaus & Co Inc | 8 | Yes | No |
| 11/08/2000 | Telik Inc | 1% | 198% | 171% | 5 | Lehman Brothers | 9 | Yes | No |
| 03/02/2005 | Threshold Pharmaceuticals Inc | 1% | -133% | -107% | 4 | Lazard Freres & Co LLC | 7 | Yes | No |
| 05/10/2004 | Theravance Inc | 13% | 7% | 10% | 4 | Merrill Lynch & Co Inc | 9 | Yes | No |
| 14/12/2016 | TiGenix NV | -25% | 98% | 139% | 3 | Morgan Stanley & Co | 9 | No | No |
| 16/09/2014 | Tokai Pharmaceuticals Inc | 58% | -266% | -143% | 4 | William Blair & Co | 8 | Yes | No |

| | | | | | | | | | |
|------------|-------------------------------|------|-------|-------|---|---------------------------------|---|-----|-----|
| 30/09/2009 | Talecris Biotherapeutics Hldg | 15% | 14% | 21% | 7 | Citi | 9 | No | Yes |
| 11/12/2013 | Tetralogic | 0% | -223% | -125% | 3 | Needham & Co LLC | 8 | Yes | No |
| 09/12/1999 | Tularik Inc | 43% | -59% | -25% | 4 | Lehman Brothers | 9 | Yes | No |
| 09/04/2010 | Tengion Inc | 0% | -272% | -131% | 2 | Leerink Swann & Co | 7 | Yes | No |
| 06/04/2000 | Tanox Inc | -4% | 53% | -12% | 7 | CIBC World Markets Inc | 8 | Yes | No |
| 17/10/2006 | Trubion Pharmaceuticals Inc | 1% | -25% | -69% | 4 | Morgan Stanley | 9 | Yes | No |
| 16/03/2004 | Tercica Inc | -2% | -52% | -78% | 4 | Lehman Brothers | 9 | Yes | No |
| 11/04/2006 | Targacept Inc | -4% | 12% | -43% | 4 | Deutsche Bank Securities Corp. | 8 | Yes | No |
| 07/10/1997 | Trimeris Inc | 2% | 218% | 309% | 2 | UBS Securities Inc | 8 | Yes | No |
| 31/01/2014 | Trevena Inc | -7% | -27% | -84% | 5 | Barclays PLC | 7 | Yes | No |
| 02/07/1997 | Transcend Therapeutics Inc | -1% | -121% | -137% | 2 | EVEREN Securities Inc | 6 | Yes | No |
| 27/06/2012 | Tesaro Inc | 2% | 121% | 263% | 5 | Citi | 9 | Yes | No |
| 02/08/2010 | Trius Therapeutics Inc | 1% | 121% | 194% | 4 | Citi | 9 | Yes | No |
| 18/01/1996 | Titan Pharmaceuticals Inc | 34% | -70% | -143% | 2 | D. H. Blair & Company, Inc. | 5 | Yes | No |
| 15/11/1996 | Twinlab Corp | 0% | -92% | -250% | 4 | Donaldson Lufkin & Jenrette Inc | 9 | No | Yes |
| 09/02/2001 | Third Wave Technologies Inc | 1% | 46% | -42% | 5 | Lehman Brothers | 9 | Yes | No |
| 17/06/1999 | United Therapeutics Corp | 2% | 145% | 16% | 3 | BT Alex Brown Inc | 8 | No | No |
| 30/09/2014 | Vascular Biogenics Ltd | -1% | 195% | -31% | 3 | JMP Securities LLC | 8 | Yes | No |
| 29/10/2013 | Veracyte Inc | 2% | -13% | -72% | 4 | Morgan Stanley & Co | 9 | Yes | No |
| 02/08/2000 | Versicor Inc | -12% | 126% | 69% | 4 | Lehman Brothers | 9 | Yes | No |
| 21/07/2000 | Variagenics Inc | 75% | -164% | -27% | 3 | CS First Boston Corp | 9 | Yes | No |
| 20/01/2005 | ViaCell Inc | 25% | -14% | -60% | 4 | Credit Suisse First Boston Corp | 8 | Yes | No |
| 31/10/1996 | Triangle Pharmaceuticals Inc | 9% | -84% | -259% | 3 | Dillon, Read & Co Inc | 7 | Yes | No |
| 10/06/1998 | VI Technologies Inc | -5% | -14% | -56% | 2 | Cowen & Co | 8 | Yes | No |
| 28/04/2015 | Viking Therapeutics Inc | 13% | 119% | -25% | 2 | Laidlaw & Co (UK) Ltd | 5 | No | No |
| 01/02/2006 | Valera Pharmaceuticals Inc | 12% | -14% | -21% | 4 | Banc of America Securities LLC | 8 | Yes | No |
| 12/04/2006 | Vanda Pharmaceuticals Inc | -3% | -48% | -68% | 3 | Banc of America Securities LLC | 8 | Yes | No |
| 19/11/1996 | ViroPharma Inc | 0% | 141% | 108% | 2 | Cowen & Co | 8 | Yes | No |
| 26/04/2007 | Pharmasset Inc | 1% | 181% | 256% | 3 | Banc of America Securities LLC | 8 | Yes | No |

| | | | | | | | | | |
|------------|-----------------------------------|------|-------|-------|----|--|---|-----|-----|
| 20/03/2014 | Versartis Inc | 51% | -31% | -87% | 4 | Citigroup Global Markets Inc | 8 | Yes | No |
| 26/01/2012 | Verastem Inc | 10% | -63% | -103% | 5 | Leerink Swann & Co | 7 | Yes | No |
| 24/09/2014 | Vitae Pharmaceuticals Inc | -5% | 195% | 43% | 5 | BMO Capital Markets | 7 | Yes | No |
| 16/04/2014 | Vital Therapies Inc | 0% | -11% | -124% | 4 | Credit Suisse Securities (USA) LLC | 8 | Yes | No |
| 16/12/2010 | Ventrus Biosciences Inc | 5% | -12% | -83% | 2 | National Securities Corp (US) | 7 | No | No |
| 29/07/2015 | vTv Therapeutics Inc | -28% | -167% | -157% | 4 | Piper Jaffray Cos | 8 | No | No |
| 10/11/2015 | Voyager Therapeutics Inc | 27% | -8% | -90% | 5 | Piper Jaffray Cos | 8 | Yes | No |
| 04/02/1998 | Vysis Inc(BP Amoco PLC) | 1% | 91% | -47% | 3 | Furman Selz LLC | 7 | No | No |
| 20/09/2006 | Warner Chilcott Holdings Co | 0% | 68% | 81% | 9 | Deutsche Bank Securities Corp. | 8 | No | Yes |
| 28/06/1999 | Women First Healthcare Inc | 4% | 221% | -6% | 2 | Allen & Co Inc | 8 | Yes | No |
| 30/04/1997 | Weider Nutrition International | 0% | -209% | -255% | 4 | CS First Boston Corp | 9 | No | No |
| 10/11/2015 | Wave Life Sciences Ltd | 0% | 114% | 131% | 4 | Jefferies & Co Inc | 8 | Yes | No |
| 08/08/2007 | WuXi PharmaTech(Cayman)Inc | 43% | 31% | -27% | 3 | Jefferies & Co Inc | 8 | No | Yes |
| 14/04/2015 | XBiotech Inc | 22% | -95% | -124% | 1 | WR Hambrecht & Co LLC | 7 | No | No |
| 16/03/2004 | Xcyte Therapies Inc | -9% | -169% | -119% | 4 | US Bancorp Piper Jaffray Inc | 7 | Yes | No |
| 04/11/2014 | Xenon Pharmaceuticals Inc | 17% | -190% | -131% | 3 | Canaccord Genuity | 6 | Yes | No |
| 19/09/2013 | Acceleron Pharma Inc | 33% | 55% | -8% | 4 | Citigroup Global Markets Inc | 8 | Yes | No |
| 02/12/2013 | Xencor Inc | 52% | 135% | 134% | 4 | Credit Suisse Securities (USA) LLC | 8 | Yes | No |
| 02/06/2005 | XenoPort Inc | -1% | 162% | 262% | 4 | Morgan Stanley | 9 | Yes | No |
| 07/08/2013 | Intrexon Corp | 54% | 39% | -18% | 4 | JP Morgan & Co Inc | 9 | Yes | No |
| 18/06/2014 | Zafgen Inc | 24% | -46% | -126% | 4 | Cowen & Co | 8 | Yes | No |
| 31/01/2002 | ZymoGenetics Inc | 2% | 36% | 27% | 4 | Lehman Brothers | 9 | Yes | No |
| 29/10/1997 | Zymetx Inc | 33% | -182% | -145% | 4 | Capital West Securities | 3 | Yes | No |
| 17/06/2014 | ZS Pharma Inc | 57% | 135% | 204% | 4 | JP Morgan Securities Inc | 7 | Yes | No |
| 31/01/2013 | Zoetis Inc | 18% | -2% | -13% | 20 | Guggenheim Securities LLC | 6 | No | No |
| 04/08/2015 | Zynerba Pharmaceuticals Inc | 15% | -5% | -145% | 4 | Piper Jaffray Cos | 8 | Yes | No |

Appendix 2: Underwriter Reputation Rank

Table 8.2 Underwriter Reputation Criteria

| Underwriter | Time as lead underwriter | Time as part of the syndicate | Proceeds raised when lead | Proceeds raised when part of the syndicate | Reputation score |
|-------------------------------------|--------------------------|-------------------------------|---------------------------|--|------------------|
| Merrill Lynch & Co Inc | 462 | 867 | \$ 105,077 | \$ 313,563 | 9.0 |
| Goldman Sachs & Co | 413 | 797 | \$ 117,791 | \$ 375,313 | 9.0 |
| Morgan Stanley | 124 | 842 | \$ 57,519 | \$ 374,004 | 8.9 |
| JP Morgan & Co Inc | 155 | 550 | \$ 37,916 | \$ 289,426 | 8.9 |
| Lehman Brothers | 210 | 579 | \$ 24,910 | \$ 156,333 | 8.9 |
| Citi | 64 | 504 | \$ 22,215 | \$ 291,134 | 8.8 |
| Morgan Stanley & Co | 181 | 372 | \$ 32,974 | \$ 126,143 | 8.8 |
| Donaldson Lufkin & Jenrette Inc | 176 | 460 | \$ 18,287 | \$ 82,956 | 8.7 |
| Credit Suisse | 55 | 462 | \$ 10,697 | \$ 223,259 | 8.7 |
| Bear Stearns & Co Inc | 117 | 398 | \$ 13,141 | \$ 118,151 | 8.7 |
| Citigroup | 60 | 305 | \$ 23,512 | \$ 147,868 | 8.7 |
| UBS Investment Bank | 70 | 296 | \$ 19,471 | \$ 115,270 | 8.6 |
| Salomon Smith Barney | 68 | 258 | \$ 19,859 | \$ 112,848 | 8.6 |
| CS First Boston Corp | 136 | 247 | \$ 18,484 | \$ 73,665 | 8.6 |
| Alex Brown & Sons Inc | 221 | 422 | \$ 17,234 | \$ 36,561 | 8.6 |
| Raymond James & Associates Inc | 51 | 443 | \$ 5,108 | \$ 136,309 | 8.5 |
| Bank of America Merrill Lynch | 52 | 196 | \$ 19,779 | \$ 129,548 | 8.5 |
| Prudential Securities Inc | 93 | 348 | \$ 8,652 | \$ 69,529 | 8.5 |
| PaineWebber Inc | 117 | 344 | \$ 10,694 | \$ 59,198 | 8.5 |
| RBC Capital Markets | 32 | 420 | \$ 6,809 | \$ 211,369 | 8.5 |
| Deutsche Bank Securities Corp. | 46 | 239 | \$ 13,352 | \$ 127,160 | 8.5 |
| William Blair & Co | 77 | 401 | \$ 3,937 | \$ 79,840 | 8.5 |
| Oppenheimer & Co Inc | 68 | 338 | \$ 4,845 | \$ 101,263 | 8.4 |
| Morgan Stanley Dean Witter & Co | 95 | 139 | \$ 34,827 | \$ 59,883 | 8.4 |
| Banc of America Securities LLC | 44 | 237 | \$ 7,611 | \$ 108,070 | 8.4 |
| Barclays | 31 | 214 | \$ 6,747 | \$ 150,148 | 8.3 |
| Montgomery Securities | 142 | 392 | \$ 5,564 | \$ 32,451 | 8.3 |
| Credit Suisse First Boston Corp | 56 | 159 | \$ 11,598 | \$ 70,419 | 8.3 |
| Stifel Nicolaus & Co Inc | 35 | 378 | \$ 3,205 | \$ 119,501 | 8.3 |
| Jefferies & Co Inc | 48 | 244 | \$ 7,277 | \$ 52,317 | 8.3 |
| Wells Fargo Securities LLC | 25 | 191 | \$ 11,568 | \$ 111,422 | 8.3 |
| Cowen & Co | 67 | 308 | \$ 3,175 | \$ 52,137 | 8.3 |
| Piper Jaffray Cos | 50 | 206 | \$ 4,385 | \$ 56,849 | 8.2 |
| Salomon Brothers Inc | 66 | 193 | \$ 7,749 | \$ 35,821 | 8.2 |
| Hambrecht & Quist Inc | 141 | 362 | \$ 5,366 | \$ 19,423 | 8.2 |
| Robert W Baird & Co Inc | 29 | 328 | \$ 1,864 | \$ 97,593 | 8.2 |
| Piper Jaffray Inc | 45 | 337 | \$ 3,392 | \$ 40,930 | 8.1 |
| Smith Barney Incorporated | 77 | 178 | \$ 7,833 | \$ 24,342 | 8.1 |
| Deutsche Bank Securities Inc | 22 | 132 | \$ 9,331 | \$ 79,439 | 8.1 |
| UBS Securities Inc | 30 | 108 | \$ 5,677 | \$ 52,399 | 8.0 |
| UBS Warburg | 27 | 116 | \$ 5,901 | \$ 49,479 | 7.9 |
| Robertson Stephens & Co | 122 | 217 | \$ 4,910 | \$ 10,197 | 7.9 |
| Credit Suisse Securities (USA) LLC | 26 | 105 | \$ 6,571 | \$ 45,078 | 7.9 |
| CIBC World Markets Inc | 23 | 173 | \$ 1,859 | \$ 56,068 | 7.9 |
| Ladenburg Thalmann & Co | 26 | 181 | \$ 1,136 | \$ 56,005 | 7.8 |
| Citigroup Global Markets Inc | 19 | 91 | \$ 5,490 | \$ 51,815 | 7.8 |
| Thomas Weisel Partners | 23 | 209 | \$ 1,374 | \$ 27,785 | 7.7 |
| Allen & Co Inc | 15 | 74 | \$ 16,514 | \$ 43,022 | 7.7 |
| Needham & Co LLC | 36 | 244 | \$ 990 | \$ 17,159 | 7.7 |
| SG Cowen Securities Corp | 24 | 140 | \$ 1,286 | \$ 24,405 | 7.6 |
| BT Alex Brown Inc | 38 | 85 | \$ 2,923 | \$ 17,403 | 7.6 |
| Merrill Lynch Pierce Fenner & Smith | 16 | 72 | \$ 9,148 | \$ 30,967 | 7.6 |
| JMP Securities LLC | 17 | 181 | \$ 1,220 | \$ 29,201 | 7.6 |
| Wedbush Securities | 12 | 202 | \$ 459 | \$ 67,987 | 7.5 |
| Robinson-Humphrey Co | 32 | 138 | \$ 1,067 | \$ 11,944 | 7.5 |
| US Bancorp Piper Jaffray Inc | 17 | 149 | \$ 1,026 | \$ 18,199 | 7.4 |
| JP Morgan Securities Inc | 14 | 63 | \$ 4,996 | \$ 23,615 | 7.4 |

| | | | | | | | |
|---|----|-----|----|-------|----|---------|-----|
| Fleet Boston Corp,Boston,Massachusetts | 26 | 85 | \$ | 1,930 | \$ | 10,891 | 7.3 |
| Dillon, Read & Co Inc | 35 | 81 | \$ | 2,184 | \$ | 6,012 | 7.3 |
| BMO Capital Markets | 10 | 99 | \$ | 650 | \$ | 43,808 | 7.2 |
| SunTrust Robinson Humphrey | 9 | 99 | \$ | 920 | \$ | 33,750 | 7.2 |
| Chase H&Q | 21 | 70 | \$ | 1,340 | \$ | 11,426 | 7.2 |
| Lazard Capital Markets | 10 | 70 | \$ | 1,064 | \$ | 35,143 | 7.2 |
| Maxim Group LLC | 7 | 121 | \$ | 544 | \$ | 42,481 | 7.1 |
| Barclays PLC | 8 | 52 | \$ | 1,688 | \$ | 36,443 | 7.1 |
| Janney Montgomery Scott LLC | 5 | 149 | \$ | 325 | \$ | 64,048 | 7.0 |
| Piper Jaffray | 3 | 540 | \$ | 148 | \$ | 101,189 | 7.0 |
| Volpe Welty & Co | 22 | 91 | \$ | 782 | \$ | 3,498 | 6.9 |
| Furman Selz LLC | 16 | 74 | \$ | 640 | \$ | 8,960 | 6.9 |
| Leerink Swann & Co | 12 | 63 | \$ | 885 | \$ | 11,255 | 6.9 |
| BancAmerica Robertson Stephens Inc | 21 | 52 | \$ | 968 | \$ | 3,535 | 6.8 |
| Lazard Freres & Co LLC | 8 | 51 | \$ | 1,140 | \$ | 14,296 | 6.8 |
| WR Hambrecht & Co LLC | 18 | 35 | \$ | 883 | \$ | 6,533 | 6.7 |
| Jefferies LLC | 9 | 35 | \$ | 1,493 | \$ | 10,966 | 6.7 |
| Aegis Capital Corp. | 17 | 45 | \$ | 331 | \$ | 8,769 | 6.7 |
| Tucker Anthony Inc | 14 | 48 | \$ | 396 | \$ | 6,561 | 6.7 |
| Adams Harkness & Hill Inc | 11 | 62 | \$ | 412 | \$ | 3,830 | 6.6 |
| National Securities Corp (US) | 13 | 58 | \$ | 199 | \$ | 9,288 | 6.5 |
| Leerink Partners LLC | 11 | 34 | \$ | 976 | \$ | 4,222 | 6.5 |
| Wedbush Securities, Inc. | 3 | 89 | \$ | 268 | \$ | 33,973 | 6.5 |
| Paulson Investment Co | 20 | 31 | \$ | 321 | \$ | 3,356 | 6.4 |
| EVEREN Securities Inc | 9 | 41 | \$ | 249 | \$ | 5,467 | 6.3 |
| Guggenheim Securities LLC | 2 | 30 | \$ | 2,639 | \$ | 19,788 | 6.3 |
| Warburg Dillon Read Inc | 3 | 39 | \$ | 342 | \$ | 15,927 | 6.2 |
| Josephthal Lyons & Ross Inc | 21 | 32 | \$ | 319 | \$ | 1,069 | 6.2 |
| CE Unterberg Towbin | 10 | 32 | \$ | 277 | \$ | 3,186 | 6.1 |
| Roth Capital Partners Inc | 10 | 35 | \$ | 295 | \$ | 2,042 | 6.1 |
| Canaccord Genuity | 3 | 78 | \$ | 144 | \$ | 10,114 | 6.0 |
| CIBC Oppenheimer | 8 | 23 | \$ | 457 | \$ | 1,398 | 5.9 |
| HJ Meyers & Co | 18 | 19 | \$ | 189 | \$ | 210 | 5.6 |
| CRT CAPITAL GROUP LLC | 4 | 9 | \$ | 363 | \$ | 7,084 | 5.6 |
| ThinkEquity Partners | 3 | 38 | \$ | 96 | \$ | 5,043 | 5.5 |
| Rodman & Renshaw Inc | 8 | 20 | \$ | 123 | \$ | 515 | 5.3 |
| D. H. Blair & Company, Inc. | 14 | 14 | \$ | 159 | \$ | 159 | 5.3 |
| Ladenburg Thalmann | 1 | 183 | \$ | 10 | \$ | 56,067 | 5.2 |
| Roney & Co,Detroit,Michigan | 8 | 14 | \$ | 119 | \$ | 318 | 5.1 |
| Vector Securities International | 3 | 35 | \$ | 93 | \$ | 923 | 5.0 |
| Texas Capital Securities Inc | 7 | 10 | \$ | 134 | \$ | 160 | 4.9 |
| ING Baring Furman Selz LLC | 2 | 10 | \$ | 102 | \$ | 4,364 | 4.9 |
| Blech (D.) & Company, Incorporated | 7 | 9 | \$ | 121 | \$ | 154 | 4.8 |
| First Albany Capital Inc | 2 | 12 | \$ | 104 | \$ | 1,132 | 4.6 |
| Leerink Partners | 1 | 36 | \$ | 40 | \$ | 4,526 | 4.6 |
| Dawson James Securities | 3 | 13 | \$ | 21 | \$ | 4,986 | 4.6 |
| Laidlaw & Co (UK) Ltd | 4 | 6 | \$ | 102 | \$ | 585 | 4.5 |
| MLV & Co | 1 | 18 | \$ | 38 | \$ | 4,978 | 4.4 |
| Rosenkrantz, Ehrenkrantz, Lyon & Ross | 7 | 7 | \$ | 58 | \$ | 58 | 4.2 |
| J.P. Morgan | 2 | 3 | \$ | 233 | \$ | 498 | 4.1 |
| BTIG LLC | 1 | 9 | \$ | 71 | \$ | 1,545 | 4.1 |
| Kashner Davidson Securities Corporation | 5 | 7 | \$ | 35 | \$ | 46 | 3.7 |
| Prudential Vector Healthcare | 1 | 9 | \$ | 45 | \$ | 725 | 3.7 |
| Anderson & Strudwick | 2 | 5 | \$ | 34 | \$ | 262 | 3.6 |
| Capital West Securities | 3 | 4 | \$ | 33 | \$ | 47 | 3.3 |
| Goldman Sachs (Asia) | 1 | 1 | \$ | 227 | \$ | 227 | 3.2 |
| Sunrise Securities Corp | 2 | 3 | \$ | 35 | \$ | 73 | 3.1 |
| Cantor Fitzgerald & Co. | 1 | 2 | \$ | 52 | \$ | 123 | 2.7 |

| | | | | | | | |
|------------------------------|---|---|----|----|----|----|-----|
| Merrill Lynch & Co. | 1 | 1 | \$ | 79 | \$ | 79 | 2.6 |
| Kashner Davidson Securities | 1 | 8 | \$ | 11 | \$ | 57 | 2.5 |
| Oscar Gruss & Son Inc | 1 | 3 | \$ | 16 | \$ | 50 | 2.1 |
| LT Lawrence & Co Inc | 1 | 1 | \$ | 11 | \$ | 11 | 1.1 |
| MDB Capital Group LLC | 1 | 1 | \$ | 10 | \$ | 10 | 1.0 |
| Bonwick Capital Partners LLC | 1 | 1 | \$ | 9 | \$ | 9 | 1.0 |
| WallachBeth Capital LLC | 1 | 1 | \$ | 5 | \$ | 5 | 0.5 |

Appendix 3: Most Common Venture Capital in the Biotech Sample

Table 8.3 Top 62 Venture Capital Firms Involved with Biotech Companies

| Venture Capital Firm | Times involved in a Biotech IPO | Venture Capital Firm | Times involved in a Biotech IPO |
|----------------------------------|---------------------------------|------------------------------------|---------------------------------|
| OrbiMed Advisors LLC | 43 | InterWest Partners LLC | 15 |
| MPM Capital LLC | 43 | Advent International Corp | 15 |
| Venrock Inc | 40 | Bay City Capital LLC | 14 |
| Alta Partners | 40 | Delphi Ventures | 14 |
| New Enterprise Associates Inc | 40 | Technology Partners | 14 |
| Domain Associates LLC | 39 | Sr One Ltd | 14 |
| Sofinnova Investments Inc | 36 | Warburg Pincus LLC | 13 |
| Pliant Corp | 26 | Lumira Capital Investment Manager | 13 |
| Aisling Capital LLC | 26 | GoldPoint Partners LLC | 13 |
| Frazier Management LLC | 23 | Dlj Merchant Banking Partners | 12 |
| Arch Venture Partners LLC | 22 | Foresite Capital Management LLC | 12 |
| Sprout Group | 22 | Rho Capital Partners Inc | 12 |
| Johnson & Johnson Innovation-JJI | 22 | Third Rock Ventures LLC | 11 |
| Novo Holdings A/S | 21 | T. Rowe Price Threshold Partnershi | 11 |
| Ra Capital Management LP | 21 | Canaan Partners | 11 |
| Novartis Venture Funds | 20 | Bio*One Capital Pte Ltd | 11 |
| Oxford Bioscience Partners | 20 | Skyline Ventures Inc | 11 |
| Vivo Capital LLC | 19 | Jafco Co Ltd | 11 |
| Polaris Growth Management LLC | 19 | Burrill & Company | 11 |
| HBM Healthcare Investments AG | 19 | Care Capital LLC | 11 |
| Hercules Capital Inc | 19 | Forward Ventures | 11 |
| Kleiner Perkins | 19 | Opus Capital | 11 |
| Versant Venture Management LLC | 18 | Bessemer Venture Partners | 10 |
| Abingworth Management Ltd | 18 | Sanofi-Genzyme BioVentures | 10 |
| Atlas Venture Advisors Inc | 18 | Vulcan Capital | 10 |
| TVM Capital GmbH | 17 | Sanderling Ventures | 10 |
| ProQuest Investments | 17 | Medimmune LLC | 10 |
| Healthcare Ventures LLC | 17 | Avalon Ventures | 10 |
| Flagship Pioneering | 15 | Oak Investment Partners | 10 |
| Merlin Nexus | 15 | F-Prime Inc | 9 |
| SVHealth Investors LLP | 15 | Fidelity Investment Funds II | 9 |
| Prospect Venture Partners | 15 | Deerfield Management Company LI | 9 |

Appendix 4: Correlation Matrixes for the Multivariate Regressions

Table 10.4 Correlation Matrix for the Underpricing Regression

| | MAAR | Ln(Proceeds) | Underwriter Rank | Syndicate Size | VCDummy | PEDummy | HAYDummy |
|-----------------|-------|--------------|------------------|----------------|---------|---------|----------|
| MAAR | 1.00 | 0.26 | 0.08 | 0.03 | 0.04 | -0.06 | 0.00 |
| Ln(Proceeds) | 0.26 | 1.00 | 0.37 | 0.47 | -0.03 | 0.26 | -0.06 |
| UnderwriterRank | 0.08 | 0.37 | 1.00 | 0.16 | 0.25 | -0.02 | 0.04 |
| SyndicateSize | 0.03 | 0.47 | 0.16 | 1.00 | 0.01 | 0.19 | -0.06 |
| VCDummy | 0.04 | -0.03 | 0.25 | 0.01 | 1.00 | -0.50 | 0.05 |
| PEDummy | -0.06 | 0.26 | -0.02 | 0.19 | -0.50 | 1.00 | 0.00 |
| HAYDummy | 0.00 | -0.06 | 0.04 | -0.06 | 0.05 | 0.00 | 1.00 |

Table 10.5 Correlation Matrix for the 36-Months BAHR Regression

| | BAHR | Ln(Proceeds) | Underwriter Rank | Syndicate Size | VCDummy | PEDummy | HAYDummy | MAAR |
|-----------------|-------|--------------|------------------|----------------|---------|---------|----------|-------|
| BAHR | 1.00 | 0.15 | 0.13 | 0.14 | 0.09 | 0.07 | -0.07 | -0.02 |
| Ln(Proceeds) | 0.15 | 1.00 | 0.37 | 0.47 | -0.03 | 0.26 | -0.06 | 0.26 |
| UnderwriterRank | 0.13 | 0.37 | 1.00 | 0.16 | 0.25 | -0.02 | 0.04 | 0.08 |
| SyndicateSize | 0.14 | 0.47 | 0.16 | 1.00 | 0.01 | 0.19 | -0.06 | 0.03 |
| VCDummy | 0.09 | -0.03 | 0.25 | 0.01 | 1.00 | -0.50 | 0.05 | 0.04 |
| PEDummy | 0.07 | 0.26 | -0.02 | 0.19 | -0.50 | 1.00 | 0.00 | -0.06 |
| HAYDummy | -0.07 | -0.06 | 0.04 | -0.06 | 0.05 | 0.00 | 1.00 | 0.00 |
| MAAR | -0.02 | 0.26 | 0.08 | 0.03 | 0.04 | -0.06 | 0.00 | 1.00 |

Table 10.6 Correlation Matrix for the 36-Months CAR Regression

| | CAR | Ln(Proceeds) | Underwriter Rank | Syndicate Size | VCDummy | PEDummy | HAYDummy | MAAR |
|-----------------|-------|--------------|------------------|----------------|---------|---------|----------|-------|
| CAR | 1.00 | 0.09 | 0.14 | 0.13 | 0.08 | 0.00 | 0.08 | -0.05 |
| Ln(Proceeds) | 0.09 | 1.00 | 0.37 | 0.47 | -0.03 | 0.26 | -0.06 | 0.26 |
| UnderwriterRank | 0.14 | 0.37 | 1.00 | 0.16 | 0.25 | -0.02 | 0.04 | 0.08 |
| SyndicateSize | 0.13 | 0.47 | 0.16 | 1.00 | 0.01 | 0.19 | -0.06 | 0.03 |
| VCDummy | 0.08 | -0.03 | 0.25 | 0.01 | 1.00 | -0.50 | 0.05 | 0.04 |
| PEDummy | 0.00 | 0.26 | -0.02 | 0.19 | -0.50 | 1.00 | 0.00 | -0.06 |
| HAYDummy | 0.08 | -0.06 | 0.04 | -0.06 | 0.05 | 0.00 | 1.00 | 0.00 |
| MAAR | -0.05 | 0.26 | 0.08 | 0.03 | 0.04 | -0.06 | 0.00 | 1.00 |