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Can Venture Capitalists in Biotechnology Time the Market?

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Abstract:

This paper investigates the ability of venture capitalists to time market conditions when deciding between public and private financings as well as issuance of follow-on offerings, focusing on a segment of the U.S. biotechnology industry. This has been assessed by studying the timing of public vs. private financings measured against market conditions during and around the time of financings. We find evidence of pseudo market-timing, meaning that the decision of venture capitalists to take a company public is a response to market sector run-ups, not because future market returns are predictable. Further, when examining financing events post-IPO, our findings show that there is significant correlation between firm specific returns and market sector run-ups, and the prospect of issuing new equity within one and two years post-IPO. Taking the perspective of IPOs and follow-on offerings as facilitating mechanisms for venture capitalists in the process of exiting their equity positions and realising returns on investment, it appears that venture capitalists operating in the biotechnology industry, can time the market.

Keywords: Venture Capital, IPO, Follow-on offering, Market-timing and Biotechnology

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1 Introduction

In this chapter, the link between venture capital and innovation is briefly introduced together with the motivation behind the research. Thereafter, the objective of the study is specified followed by a disposition of this thesis.

1.1 Background

The presence of venture capitalists has transformed the process of fostering innovation within high-tech industries in the United States. Innovation used to be driven by traditional mature firms with in-house research and development activities, thus slowing down the pace of innovation. With the introduction of venture capitalists – entrepreneurs drive the trajectory of innovativeness (Florida and Kenny, 1988). Most entrepreneurs depend on capital to realise their vision and different financial intermediaries can have conflicting agendas with those of the entrepreneur, leading to a situation of entrepreneurs lacking capital to finance their innovative ventures. Capital is the essence of which new venture creators can take their ideas, develop and bring them to market, thus fueling the cycle of an economy (Zauberman and Gerschenkron, 1963).

Venture capitalists can bridge the gap of conflicting agendas related to the risks associated with pursuing new ventures and have thus become an important driver for innovation (Florida and Kenny, 1988). Tian and Wang (2013) further reinforced this notion by arguing that venture capitalists have a higher tolerance for innovation failure than the typical vertically integrated firm. This implies that venture capitalists are more prone to take on the significant risks of failure, ultimately serving as better facilitators of innovation. A related finding is that of Hellman (2000), who examined the relationship between financing alternatives and go-to-market strategies. He found that firms who receive funding from venture capitalists are more likely to be innovative and establish first-mover advantage in their respective markets, compared to non venture-backed firms.

The basic idea of venture capital is to invest capital (raised through investors and pooled into a fund) in new unproven enterprises, which traditional financial institutions tend to ignore. In exchange, venture capitalists receive an equity or ownership stake, and in most cases spend the next few years steering development and providing the best possible settings for the enterprise to be successful. When these years pass, the venture capitalists look to complete an exit where a profit can be made from the initial investment. The primary options when choosing an exit are initial public offerings (IPO) and trade sales. The option that in most cases yields the highest return is taking the portfolio company public (Zider, 1998).

Venture capitalists balance their portfolio with the aim of maximizing returns taking the least amount of risk possible. This has led to specialisation in different industries, where the backing of venture capitalists often serves as proof of quality of a firm's resources or capabilities (Megginson and Weiss, 1991). One industry where the intensity of venture capital activity is considerably high is the biotechnology industry. This particular industry, which will be the focus of this study, is to some extent different in nature from what one would call normal venture creation. The main difference is the high level of risk associated with biotechnology investments. The risks are tied to the time and process of developing and bringing a product to market, which spans over a longer time-period, facing far more regulatory scrutiny than other industries, resulting in high failure and attrition rates. Bringing a bioengineered pharmaceutical product to market typically takes over a decade, and some of these companies may still be in a research-and development phase when they go public and remain so until well after. It takes time for these firms to become profitable, but usually they do not incur large up-front costs in building manufacturing facilities. Venture capitalists provide funding in stages, using each financing round to first review the status of the targeted firm. Every round also involves an assessment around the decision to go public or remain private, giving venture capitalists the flexibility and opportunity to try and time their exits according to market conditions (Lerner, 1994).

If the venture-backed firm goes public, certain requirements take effect for the venture capitalists. One example is that they become subject to a lock-up agreement, which states that they cannot sell their shares for the duration of 180 days after being listed on a stock exchange (Field et al., 2001). As venture capitalists typically operate with their portfolio firm on the public market some time after the IPO (Megginson and Weiss, 1991), new financings tend to be completed through issuance of new equity shares (follow-on offerings) for publicly listed early-stage firms (Bolton and Freixas, 2000; Rajan and Zingales, 1998; Ravid and Spiegel, 1997).

1.2 Aim of Study

The aim of this thesis is to assess the ability of venture capitalists to time market conditions when going public and issuing equity during the past two decades. Lerner (1994) found venture capitalists able to time their IPOs during high equity market valuations and that seasoned venture capitalists particularly, appear to be proficient at taking companies near market peaks. Taking a structurally similar approach, we look at the same industry, which has

grown, matured and changed[1] (Haislip, 2011). We add a second metric to assess venture capitalists' market-timing ability by examining the event of follow on offerings, since it appears that venture capitalists remain invested in the portfolio firm for at least six months post-IPO.

1.3 Thesis Disposition

The remaining sections of the study are as follows; Section 2 provides a selective literature review and theory on venture capital, its function and how they realise returns. The formal research hypotheses of this study are presented at the end. Section 3 covers methodology, data and summary statistics; from how the sample was extracted to the limitations set, followed by descriptive statistics and ending with the econometric tests employed. Section 4 presents and discusses the main results of the econometric models. Section 5 concludes and Section 6 provides references and the appendix.

[1] There have been significant regulatory changes impacting the investment banking and venture capital industry since 1994 (among others the Sarbanes-Oxley Act).

2 Theory and Research Hypothesis

Here we draw upon previously conducted research in the following areas; (1) the function of venture capital, (2) exit opportunities and market timing ability of venture capitalists and lastly, (3) post-IPO performance. Reviewing previous literature in these areas creates a link between existing knowledge and our research.

2.1 The function of Venture Capital

Metrick and Yasuda (2011) see five main features of venture capital firms; (1) they operate solely in the private market, (2) they act as a financial intermediary, (3) provide mentorship to the investment target, (4) with the goal of maximizing their financial returns through a trade sale or an initial public offering (IPO), and (5) fund the internal growth of companies. These characteristics affect the economy in different ways. For instance, when looking at the company landscape of the United States, Barry et al. (1990) stated that venture capital plays an important role in creating public firms.

The qualitative impact that venture capitalists have on young firms and the role they play often goes beyond that of a traditional financial intermediary. Extensive monitoring, i.e. by taking an active role in the target firm's board of directors enable them to maintain their influence on strategy and corporate governance (Barry et al., 1990). An example is bringing in a more experienced Chief Executive Officer (CEO), who can speed up the process of developing internal capabilities, professionalizing marketing and sales, formulating stock option plans and ramping up the recruitment process (Hellman and Puri (2002). As a result, long-term performance in venture-backed firms after IPO usually increases (Krishan et al., 2011).

In order for venture capitalists to maximize their financial returns, the issue of informational asymmetry is one of concern. Akerlof (1970) first introduced the concept of informational asymmetry through describing a hypothetical situation of discrepancy in knowledge of the quality of a used car between the seller and buyer[2]. The "lemons problem" has given birth to a wide array of implications regarding the credibility and validity of IPOs. For venture capitalists, it is critical to reduce informational asymmetry. Megginson and Weis (1991) suggest that venture capitalists can reduce information asymmetry alongside an IPO by providing credibility. They conclude that the involvement of venture capitalists in an IPO

[2] A seller might not disclose all information regarding the quality and condition of the car leaving the buyer unable to verify the quality of the car. Due to this phenomenon, sellers of high quality cars will withdraw from the market because the buyers assume all cars will be the one associated with faults. This in turns leads to unwillingness from the buyers to pay a premium for a high quality car, thus leaving the seller of a high quality car more reluctant to offer his car on the market.

lessens information asymmetry due to the level of quality they bring into the validation and quality process. To build credibility and validity, as well as mitigate risk, established venture capitalists tend to syndicate with someone of similar or better quality during first round investments (Lerner, 1994b). Admanti and Pfleiderer (1994) underlined this rationale, finding that later-round financings must also be syndicated to keep information asymmetry low. This indicates that the firm is not overpriced and that existing informational advantage is lessened, thus giving better opportunities for further investments in the fund.

2.2 Exit and Market Timing

The primary objective of this study is to investigate how well venture capitalists have been able to time their decision to take firms public for the past twenty years. Consequently, the concept of timing and different exit alternatives needs to be explained.

As described in chapter 2.1, one of the characteristics that define venture capital is the goal to maximize financial returns. These returns are realised through completing an exit. An exit is the decision by the venture capital firm to sell its stake in their portfolio company. As a result, the entity formed between the two seizes to exist. Exits can be carried in out in mainly two different forms: IPOs or trade sales[3] (Giot and Schwienbacher, 2007). Since the principal focus of this thesis is to investigate the ability of venture capitalists to time public financings, no concern will be given to trade sales.

IPOs have proven to yield far more significant returns on investment than other exit alternatives (Jeng and Wells, 2000; Gompers and Lerner, 2004). The logic behind a venture capitalist taking a firm public is that the venture capitalist can liquidate the shares of the firm in an open market (Gompers 1998). Subsequently, from the entrepreneur's point of view, an IPO can serve as a way to regain control (Black and Gilson, 1998).

Since it is imperative for venture capitalists to succeed with their IPOs, questions regarding when to take a firm public (timing) become a critical factor. Timing, or market timing, refers to the notion of selling a share for a higher price at a given point in time, than it normally would obtain (Baker et al., 2002). This is important for a number of reasons. As stated earlier, IPOs as a financing alternative yield the highest returns on investment for venture capitalists. Consequently, IPOs are preferably executed when equity values are high. However, venture capitalists rarely sell their shares at IPO, and in most cases, IPOs come with a lock-up period for existing shareholders (Gompers and Brav, 1999). A lock-up period

[3] Trade Sales for the duration of this thesis is defined as a private transaction between the venture capitalist and a counter-party. Examples of such transactions are mergers, acquisitions and/or leveraged buy-outs.

prohibits existing shareholders to sell their shares for the next 180 days after the public offering (Field et al., 2001). Albeit not a legal requirement, it is upheld to reduce information asymmetry and ensure that underwriters[4] of the IPO do not distort the IPO price (Ofek and Richardson, 2000).

Lerner (1994) examined the ability of venture capitalists to time IPOs in relation to equity market conditions. He showed that they take firms public when equity values are high and choose private financing when equity values are lower, and that experienced venture capitalists appear to be more proficient at timing IPOs. The argument that experienced venture capitalists are better at timing IPOs coincides with Gompers' (1996) *Grandstanding theory*. His theory argues that inexperienced venture capitalists, unlike their more experienced counterparts, do not have the same luxury of waiting for optimal market conditions in order to take a firm public, because of their need to signal quality to future potential investors. Added evidence to support that venture capitalists can time the market was presented by Baker and Wurgler (2000), who showed that venture capitalists react to market specific developments in order to determine which exit strategy to rely upon. Ball et al. (2011) conducted a thorough study by sampling 8,163 venture backed firms in order to test two competing hypotheses. Namely that levels and relative shares of IPOs and mergers and acquisitions are affected by market timing, versus exit choices that are driven by capital market conditions. They argue that exit waves and variation in the proportions of IPO and M&A exits are both manifestations of the same underlying considerations. Their hypotheses addressing causes are anchored in two streams of literature in finance, *the market-timing hypothesis* and the *market-conditions hypothesis*.

Staying consistent with literary works that mainly concentrate on opportunistic market timing of IPOs (e.g. Baker and Wurgler, 2002; Lowry, 2003), Ball et al (2011) derive what they refer to as the *market-timing hypothesis.* If venture capitalists can time IPOs to exploit market-or sector wide optimism, IPO activity and the propensity to exit through going public should anticipate market or sector declines or subnormal returns. On the other hand, remaining consistent with the finance literature that primarily focuses on private firm choice between IPO and M&A (e.g. Brau et al., 2003; Poulsen and Stegemoller, 2008), exit waves and the propensity to exit by going public, may be driven by capital market conditions tied to capital demand, adverse selection costs, and the relative costs of IPOs and acquisitions. This

[4] An underwriter is in most cases an investment bank that takes on the role of promoting the shares that are about to be offered to the public. In exchange for the underwriters' services, they receive a fixed discount on the shares as well as an option to buy more shares when the lock-up period expires.

is referred to as the *market conditions hypothesis* or *pseudo market timing* – a limitation of the Lerner (1994) study. Successful market timing implies market inefficiency and a transfer of wealth from new to existing investors, while the market condition factors are non-opportunistic in nature. They found evidence of pseudo market timing, meaning venture-backed issuers react to market or sector run-ups, but are unable to predict downturns.

2.3 Post-IPO Performance

So far we have presented what venture capital contributes with, as well as issues of importance to them. We link this to the notion of exit via an IPO and market timing as a way of achieving the best return on investment possible. However, an exit in reality is not complete at an IPO because existing shareholders are in most cases obliged to hold their shares for typically 180 days, due to the lock-up agreement. Therefore, post-IPO performance and activities become important, in order to fulfil the main objective of venture capitalists, namely the return on investment.

As mentioned, an IPO *per se* is not the same as an actual exit. Barry et al. (1990) examined venture-backed firms that went public and discovered that venture capitalists still hold concentrated equity positions in their portfolio firms one-year post-IPO. Megginson and Weiss (1991) confirmed that venture capitalists linger on with their equity position longer than non-venture capital actors do after IPO, which further strengthens the notion that IPOs are processes that facilitate an exit.

Gompers and Brav (1997) compared post-IPO performance between venture-backed and non venture-backed firms, concluding that the former loses less value than the latter after going public[5]. When it comes to price performance of venture-backed companies that go public, Loghran and Ritter (1995) showed that the nominal buy-and-hold returns are 50 percent lower for a firm that recently went public versus a comparable firm. Their results showed that all IPOs underperform, but that venture-backed IPOs underperform significantly less than the others. One explanation to this is that venture capitalists usually have higher equity positions in the firms that go public both before and after IPO (Megginson and Weiss, 1991). Krishnan et al. (2011) findings' support this explanation showing that venture capitalists' reputation is positively associated with the long-run firm performance.

As alluded to earlier, an initial public offering can facilitate the process for venture capitalists to exit their investment. The implication of a lock-up agreement means that venture issuers have to wait until the lock-up period expires, before they can sell off their positions in

[5] The stock price of a firm usually declines in the ensuing period after IPO. The most widely accepted explanation is that the stock price may be set too high as the market won't buy it at that price, forcing the price down to an acceptable level.

the portfolio firm. As many of these venture-backed firms may still be in a research and development phase when they go public, it is not unlikely that the need for further financial funding arises. Mayers and Majluf's (1984) *pecking order theory*, states that firms seek internal funding first, then issue debt before finally issuing equity. However, the subject of our study, the biotechnology industry, is capital intensive and firms usually do not have a finished product, from which they can generate revenue for internal funding. Enlisting on a stock exchange enables them to rely on equity capital as the primary source of funding (Jeppson and Hamberg, 2010). A method that can be used for further funding are follow-on offerings and or seasoned equity offerings[6] (SEO). Follow-on offerings and SEOs have the same characteristics, both being dilutive or non-dilutive offerings (Harper et. al, 2004). However, as they are another means of financing, the notion of timing becomes relevant, as in the case of deciding when to go public. Mayers and Majluf (1984) suggest that firms can time equity issues during periods of reduced asymmetric information. This was partly verified by Choe et al. (1995), who identified moments in time when capital can be raised at favourable terms, dubbing them "windows of opportunity". Bayless and Chaplinsky (1996) confirmed these findings, presenting evidence that the prices of newly issued equity were higher in hot markets than vice versa.

In concluding this chapter, it is clear that venture capitalists do more than merely look for investments yielding the highest possible return. They play an important role in the financing of growing innovative companies, creation of public firms and improvement of existing corporate governance doctrines. Furthermore, they not act only as financial intermediaries for entrepreneurs, but also as mitigators of information asymmetry in the financial market. IPOs are the preferred exit strategy of venture capitalists, as it in most cases yields the highest possible return on investment. Existing literature also points out that venture capitalists time their IPOs according to market conditions, which may serve as a signal of high equity valuations in a market. Venture capitalists are subject to lock-up agreements, restricting them from selling their shares at an IPO. Therefore, they need to operate with their portfolio firm on the public market before being to be able to exit. If they need additional funding, they rely on follow-on offerings and the reason for issuing a follow-on offering is done on the premises that their share price may be mispriced and that they can time a "window of opportunity' to issue new shares.

[6] Follow-on offerings and SEOs are often used interchangeable in research literature. However, there is little distinction between them. Follow-on offerings are connected to the IPO and SEOs do not necessarily have any connection to the IPO, but are usually connected to positive events in a firm's life cycle (e.g. FDA approval).

2.5 Hypotheses

We examine the timing of initial public offerings and private financings by venture capitalists within the biotechnology sector. Lerner (1994) showed that venture capitalists take firms public near market peaks and employ private financings when equity values are lower. Experienced venture capitalists also appear especially proficient at timing IPOs. This study however, is 20 years old, and the venture capital industry has evolved and matured during this period. Therefore we seek to investigate whether or not these findings are still valid these past two decades. Studies show that venture capitalists usually do not exit their investment at the event of an IPO. Thus, further support of their ability to time market peaks can be drawn from the timing of follow-on offerings. Our hypotheses are:

H1: Can venture capitalists still time IPOs near equity market peaks?

H2: If H1 indicates that venture capitalists can time IPOs during high equity market peaks, then a follow-on offering will be issued within two years after the IPO.

3 Methodology, Data and Summary Statistics

In the following chapter we present our research approach and procedure. We begin by describing data sources, their origin, and criteria for inclusion or exclusion in our sample, summary statistics and the econometric models employed, in order to test our hypotheses.

3.1 The Sample – H1

Our sample is, as stated earlier, limited to the U.S. biotechnology market since information regarding venture capital investments is difficult to gather. Being private companies, they need not disclose all their investments in public filings. Consequently, the main sources of public information are the firms in which they invest and for those that go public, information is available in IPO prospectuses and S-1 registration statements provided by the Securities and Exchange Commission (SEC**)**. Information on investments in companies that remain private is even more difficult to procure, seeing that these investments need not be publicised.

For investors, the relative performance of a venture fund is a central issue. Typically, every few years, venture capitalists raise funds, where the majority is supplied by limited partners (institutional investors, endowments and wealthy individuals). Investments in venture funds are almost always for the duration of ten years, during which funds can only be withdrawn under extreme circumstances (e.g. forcing them to liquidate the fund or find replacement capital in secondary markets). For that reason, past funds become subject to scrutiny when potential investors evaluate the performance of venture capitalists (Lerner, 1994).

Our analyses are based on data extracted from the database of venture capital financings assembled by Thomson One. Their Private Equity module, successor to Venture Xpert Web, offers detailed and global coverage of more than 38,000 venture, buyout and mezzanine[7] funds, as well as their management firms. It also contains information about over 100,000 private equity/venture capital backed companies, limited partners, investments, fundraising commitments and company valuations. It is particularly comprehensive when it comes to portfolio company data; investment data such as venture financings, the investors involved, and the amount of funds disbursed. Included are firms that have gone public and

[7]Buyout funds seek to purchase equity in private companies to gain majority control, often in order to drive through significant structural changes. Two primary buyout methods; leveraged buyouts, where the majority of the buyout sum is financed by debt, and management buyouts where existing managers acquire a large part or all of the company from either the parent company or private owners. Mezzanine financings are late-stage hybrids of debt and equity financing that gives the lender the rights to convert the debt into an ownership or equity interest if the loan is not paid back in time and in full (Metrick and Yasuda, 2011).

those that have not.

Due to the generally opaque nature and availability of information on venture capital investments, we focus on an industry in which Thomson One offers comprehensive data and information, the U.S. biotechnology industry. Besides the characteristics described earlier (see introduction), there are some additional characteristics that make this industry attractive to examine. Biotechnology firms are typically in early life-cycle stages, carrying intangible assets unrecognisable on balance sheets and devoid of commercial products. For such firms, that either are early-stage public listings or growth firms with no profits, debt financing cannot likely be attained, making equity capital the major source of funding for their investments. Investment activity is frequent thanks to the capital-intensive nature of biotechnology, forcing firms to regularly issue new equity (Jeppson and Hamberg, 2010). With all these underlying traits in mind, we can conduct a study on market timing isolating equity financing as the key driver. We examine both public and private financings when studying IPO timing and performance. The datasets include IPOs and private financing rounds executed between December 12th 1994 and December 31st 2013. The information amassed by Thomson One, with regards to Biotechnology and Life Sciences is organized into "human", "animal", "industrial", "sensors", "equipment", "research" and "other". We choose to focus on "biotechnology-human" as this represents the largest sector in terms size and investments (i.e. IPO activity and private financing activity). Table 1 shows the distribution of biotechnology IPOs between 1994 and 2013.

Table 1
Biotechnology IPOs 1/1/1994-12/31/13

Human	316	78.80%
Research	22	5.49%
Industrial	19	4.74%
Equipment	19	4.74%
Animal	18	4.49%
Sensors	5	1.25%
Other	2	0.50%
Total	401	100%

Thomson One, 2014

As displayed above, the "human" sector accounts for almost 80% of the IPOs of biotechnology firms during this time period. The sample of firms operate in the following industries, as classified by Standard Industrial Classification (SIC):

Table 2

SIC Code	Description
2834	Pharmaceutical Preparations
2835	In Vitro and In Vivo Diagnostic Substances
2836	Biological Products, Except Diagnostic Substances
3826	Laboratory Analytical Instruments
3841	Surgical and Medical Instruments and Apparatus
3845	Electromedical & Electrotherapeutic Apparatus
8071	Medical Laboratories
8731	Commercial Physical and Biological Research
8734	Testing Laboratories

Occupational Safety & Health Administration, 2014

The resulting sample, summarized in table 3 consists of 1161 financings by privately held venture-backed biotechnology companies. These include 191 IPOs and 970 private financings. We extract our sample in US dollars. The public financings raised a total of $12.27 billion and the private financings $11.14 billion (both figures are gross amounts, prior to deduction expenses associated with the equity sales). Mean amounts raised were $53.96 million for IPOs and $11.36 for private financings. Firms in the sample went public after as few as one round of venture financing or as many as nineteen. The mean firm went public 7.6 years after being founded, the median after 6.2 years. This can be contrasted to Lerner's (1994) sample of 136 venture-backed biotechnology IPOs between 1978 and 1992, where the mean age was 4.8 years and the median 4.3 years. Compared to Lerner's study, our study includes 55 more IPOs, while the mean age and median age of the financed ventures have increased. Year 1996, 2000, 2004, and 2013 are years with noteworthy high IPO activity, indicating so-called "IPO-windows". All four years witnessed 18 or more venture-backed biotechnology IPOs, with 2013 accounting for 20% of all IPOs in the period we examine.

3.1.1 The IPO dataset

This dataset consists of formerly venture-backed biotechnology firms that went public between the period December 12th 1994 and Dec 31st 2013, listing the number of IPOs in each year, the total amount raised through the IPO, and average and median amount raised. Firms that do not have at least half of their private financing rounds falling within this time period were excluded from the sample. This resulted in a sample of 191 firms. A majority of these firms were (or are) listed on NASDAQ.

3.1.2 The private financing dataset

These data comprise the private financing rounds belonging to firms in the IPO dataset that went public between December 12th 1994 and December 31st 2013. The average number of private financing rounds is 12.4. Some firms have private financing rounds that took place before December 12th 1994. Therefore we have excluded from the sample, those firms that do not have at least half of their private financing rounds between December 12th, 1994 and December 31st, 2013.

3.1.3 Common features for both datasets

With regards to investment rounds we have included both equity and debt issues in their various structures, as they are all mechanisms for raising cash to the firm. Any companies with missing entries such as "total funding to date" or "investment dates" have been excluded to avoid tampering with the samples.

3.1.4 The biotechnology index

For this study we have used the NASDAQ Biotechnology Index, which was introduced on December 12, 1994. The index includes securities of NASDAQ-listed companies classified according to the Industry Classification Benchmark as either Biotechnology or Pharmaceuticals, which also meet other eligibility criteria. Furthermore, the index is calculated under a modified capitalization-weighted methodology. Companies listed in the index must fulfil the criteria of $200 million in market capitalization and 100,000 shares average daily trading volume.[8] There are currently[9] 121 components of NASDAQ Biotechnology Index. The idea behind using an index is to have a benchmark of the economic climate in the biotechnology industry, which we can employ to compare and assess the timings of initial public offerings, private financings and follow-on offerings.

[8] See appendix for more on the NASDAQ Biotechnology Index capitalization-weighted methodology and security eligibility criteria.
[9] April 30th, 2014

Table 3

Distribution of the sample. The table displays by year and cumulative size (in millions of $) the number of public and private financings by privately held biotechnology companies, which had already received venture capital. The gross amount is reported for both public and private financings, before any deductions for offering cost.

	Public financings (IPOs) by private venture-backed firms					Private financings by private venture-backed firms				
Year	Number of IPOs	% of total	Total $ raised	Mean $ raised	Median $ raised	Number of rounds	% of total	Total $ raised	Mean $ raised	Avg # of PF rounds
1995	6	3.14%	164.3	27.38	25.80	35	3.61%	177.65	5.08	5.83
1996	18	9.42%	484.58	26.92	22.57	56	5.77%	578.83	10.34	3.11
1997	13	6.81%	356.6	27.43	24.00	45	4.64%	358.57	7.97	3.46
1998	5	2.62%	111.05	22.21	16.90	53	5.46%	131.65	2.48	10.60
1999	3	1.57%	155.63	51.88	46.35	47	4.85%	130.70	2.78	15.67
2000	22	11.52%	1964.04	89.27	78.89	73	7.53%	900.12	12.33	3.32
2001	5	2.62%	200.54	40.11	49.00	48	4.95%	168.80	3.52	9.60
2002	1	0.52%	10.5	10.50		48	4.95%	1,013.93	21.12	48.00
2003	4	2.09%	286	71.50	71.00	60	6.19%	441.38	7.36	15.00
2004	18	9.42%	1229.64	68.31	56.07	63	6.49%	1,923.34	30.53	3.50
2005	7	3.66%	361.47	51.64	42.79	51	5.26%	649.18	12.73	7.29
2006	12	6.28%	693.19	57.77	52.26	52	5.36%	1,277.39	24.57	4.33
2007	10	5.24%	638.97	63.90	61.09	47	4.85%	712.84	15.17	4.70
2008	1	0.52%	5.78	5.78		56	5.77%	40.00	0.71	56.00
2009	2	1.05%	153.80	76.90		53	5.46%	247.93	4.68	26.50
2010	10	5.24%	965.24	96.52	63.34	55	5.67%	1,256.93	22.85	5.50
2011	7	3.66%	518.30	74.04	54.00	53	5.46%	578.54	10.92	7.57
2012	8	4.19%	618.78	77.35	79.30	37	3.81%	928.48	25.09	4.63
2013	39	20.42%	3,350.36	85.91	75.00	38	3.92%	639.88	16.84	0.97
Total	191	100%	12268.77	53.96		970	100%	11,142.21	11.36	12.40

Thomson One, 2014

The following graphs depict the development of NASDAQ Biotechnology Index between December 1994 and December 2013, and the number of biotechnology IPOs and private financings in each month. Figure 1 identifies what resembles "IPO windows" in years 2000, 2004 and 2013 (i.e. periods in time where peak equity levels coincide with IPO activity). Figure 2 show no clear pattern in the timing of private financings in relation to equity levels.

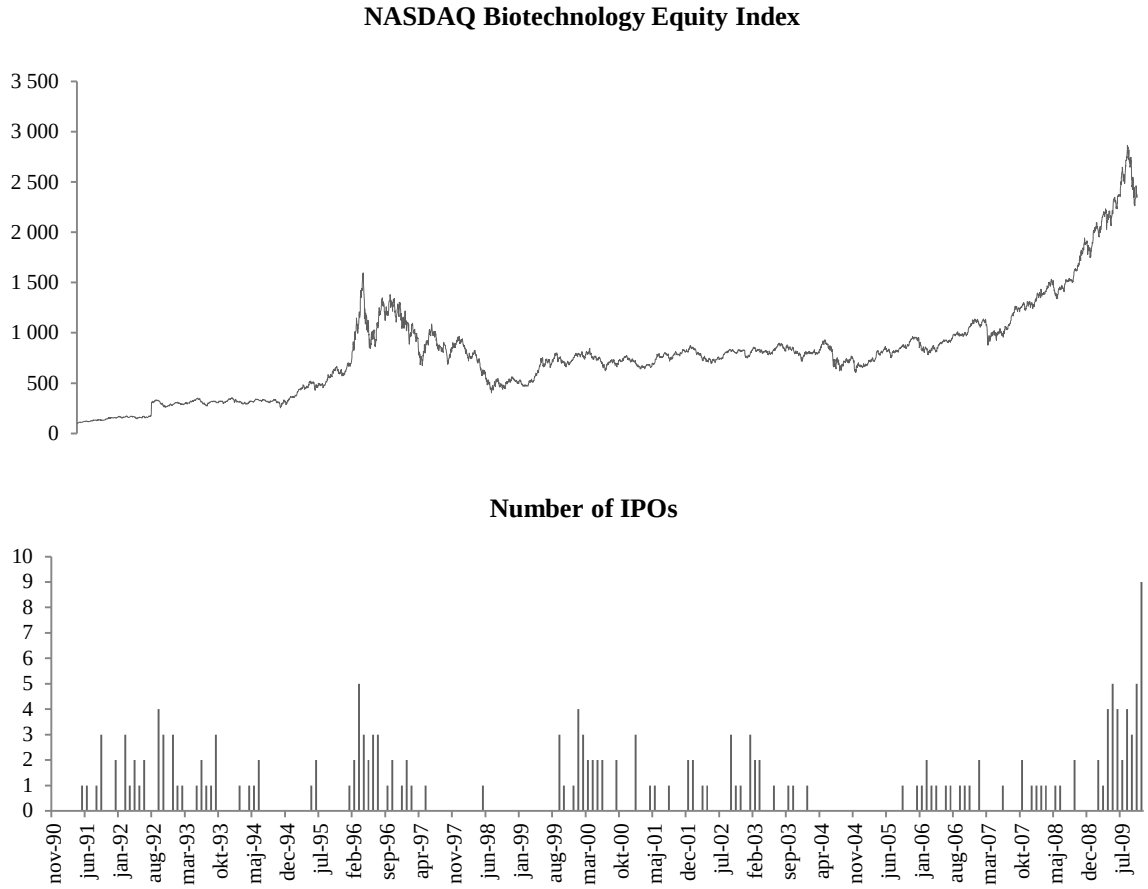

Figure 1. The timing of initial public offerings by privately held venture-backed biotechnology companies between December 1994 and December 2013. The top graph depicts the NASDAQ Biotechnology Index, while the bottom plot represents the number of biotechnology IPOs in each month. The data are compiled from NASDAQ and Thomson One – Private Equity.

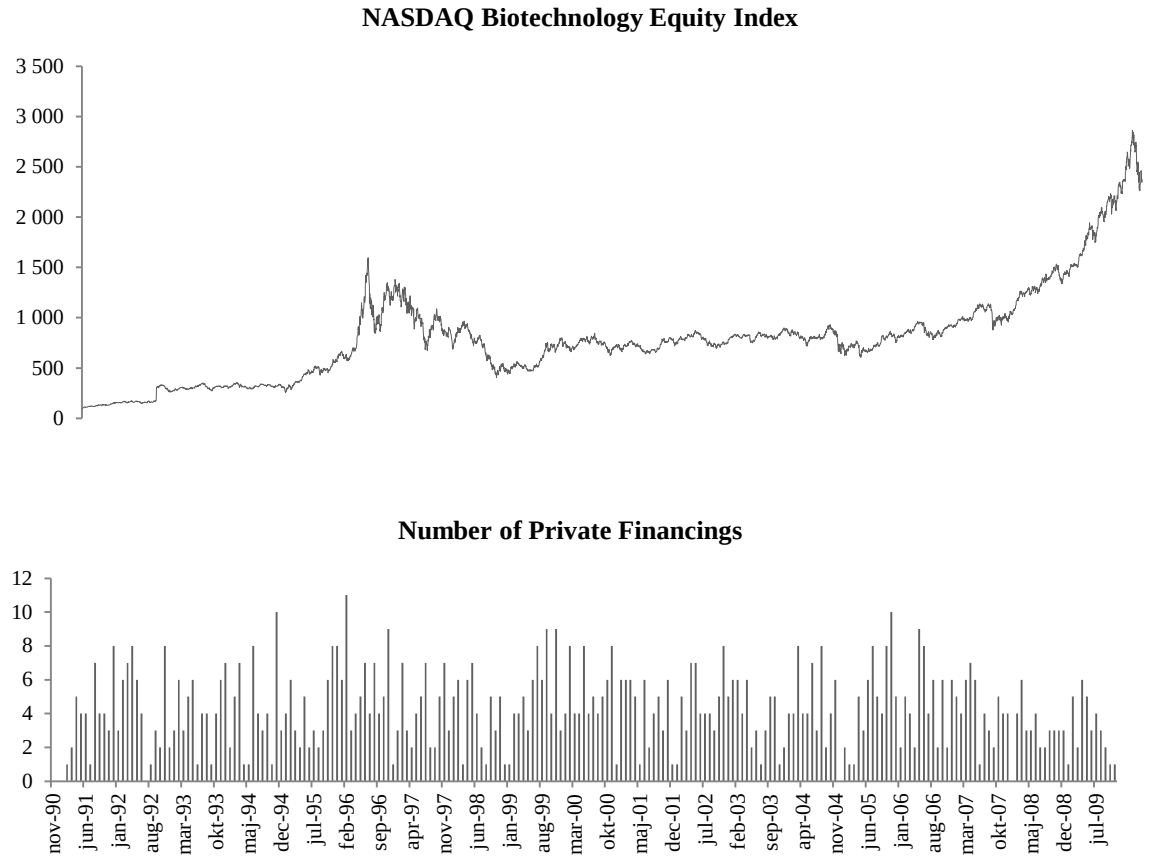

Figure 2. The timing of private financings by privately held venture-backed biotechnology companies between December 1994 and December 2013. The top graph depicts the NASDAQ Biotechnology Index, while the bottom plot represents the number of biotechnology private financings in each month. The data are compiled from NASDAQ and Thomson One – Private Equity.

3.1.5 Econometric model

For hypothesis 1, we assess market conditions and changes around and at the time of exit in three intervals before and after the financing event. Consistent with previous studies conducted on market timing (e.g. Lerner 1994, Baker and Wurgler 2000, Ball et al 2011), we employ probit models to test for whether market timing affects the choice of exit on the back of a bivariate framework. Our observations are each financing by biotechnology companies that previously received venture capital funding. We differentiate between firms who raise financings publicly (i.e. IPO) and those who remain in the private sphere, acting as our dependent variables. Independent variables consist of different measures of market timing. We employ the subsequent models:

$$\Pr obit(IPO)_i = \alpha_0 + \alpha_1 INDEX_i + \alpha_1 60 daysbefore_i + \alpha_2 60 daysafter_i + \varepsilon_{it}$$

$$\Pr obit(IPO)_i = \alpha_0 + \alpha_1 INDEX_i + \alpha_1 90 daysbefore_i + \alpha_2 90 daysafter_i + \varepsilon_{it}$$

$$\Pr obit(IPO)_i = \alpha_0 + \alpha_1 INDEX_i + \alpha_1 120\, daysbefore_i + \alpha_2 120\, daysafter_i + \varepsilon_{it}$$

3.2 The Sample – H2

As an additional metric to measure the ability of venture capitalists to time the market, and to test our second hypothesis, we look at the event of follow-on offerings among the firms in our H1 sample. To approximate the probability of follow-on offerings requires observations of both issuing and non-issuing events. Firms can either issue primary or secondary shares. Primary shares are newly created shares offered by the firm, while secondary shares are existing shares held by insiders or stockholders. We consider only public offerings where the company made new shares available and received cash, because only issuance of primary shares results in capital inflow to the firm, which can be used to finance further development.

3.2.1 Follow-on offerings dataset

For issuing firms, the sample is constructed from the Thomson Reuters Datastream database through identifying changes in the number of shares outstanding for the sample firms in the following 240 and 480 trading days post-IPO. Using corporate websites and annual reports we identified equity announcement dates and equity-issue data. This resulted in a sample of 27 firms that issued primary shares within one year, and 38 firms within two years. The observations in our study are primary shares (shares offered by the firm), and not secondary shares (shares offered by existing shareholders e.g. venture capitalists), meaning this is capital inflow to the company and not shareholders. Because most firms in our sample only make available press releases going back a few years on their websites, the majority of the follow-on offerings we discovered were in 2005 and onwards. Thus, the number of issuing firms within one or two years could likely be greater if SEC-filings for the firms with IPOs earlier in our sample period were investigated.

3.2.2 Non follow-on offerings dataset

For non-issuing firms, the sample is constructed through random number generation, following Guo and Mech (2000) and Jeppson and Hamberg (2010). We restrict the sample by generating randomly selected numbers between 22 and 730[10]. Twelve observations are

[10] Matches the time period, measured in days, in which issuing firms in our sample completed follow-on offerings.

deleted due to incomplete data, leaving us with final samples of 27 issuing firms and 152 non-issuing firms within one year, and 38 issuing firms and 141 non-issuing firms within two years. For the 11 firms that issued primary shares in year two, we generate random numbers and place them in the non-issuing group during year one. Table 4 presents the distribution of the number of equity-issues per year, average number of days before equity-issue and the total, mean and median amounts raised.

3.2.3 Econometric model

For hypothesis 2, we investigate the timing of follow-on offerings up against firm specific returns and index returns between initial public offering and follow-on offering.

Table 4

Distribution of the sample. The table displays year by year cumulative size (in millions of $) the number of issued and non-issued follow-on offerings by former privately held biotechnology companies which had already received venture capital. The gross amount is reported for both public and private financings, before any deductions for offering cost.

	Sample of follow-on offerings						Sample of no follow-on offerings		
Year	Number of issues	% of total	Mean number of days	$ amount raised	Mean $ amount raised	Median $ amount raised	Number of issues	% of total	Mean number of days
1995	0						3	2.13%	50.33
1996	0						9	6.38%	159.22
1997	1	2.63%	264	29.25			15	10.64%	168.73
1998	0						7	4.96%	224.71
1999	0						2	1.42%	312.50
2000	3	7.89%	145.3	216.65	72.22	87.21	17	12.06%	148.94
2001	1	2.63%	294	159.64			9	6.38%	186.11
2002	0						0	0.00%	
2003	0						2	1.42%	170.50
2004	1	2.63%	238	220.80			8	5.67%	154.63
2005	3	7.89%	305.3	130.23	43.41	35.60	11	7.80%	240.73
2006	1	2.63%	605	66.51			6	4.26%	225.83
2007	2	5.26%	459	157.88	78.94	78.94	10	7.09%	195.40
2008	1	2.63%	272	59.06			5	3.55%	230.20
2009	0						0		
2010	0						2	1.42%	148.00
2011	3	7.89%	289.7	237.73	79.24	71.23	5	3.55%	252.20
2012	3	7.89%	427.3	229.18	76.39	75	2	1.42%	262.00
2013	11	28.95%	323.5	681.37	61.94	60	11	7.80%	79.55
2014	8	21.05%	193.9	770.50	96.31	105.80	17	12.06%	100.12
Total	38			2,958.78			141		

Thomson Datastream and corporate websites, 2014

Observations consist of the development of share prices and change in number of shares outstanding from the event of an IPO until the announcement date of a new equity offering. Consistent with the method in hypothesis 1, we employ probit models. Through random number generation we are able assign values to non-issuing firms enabling us to differentiate between biotechnology firms who issue new equity versus those who do not. We use the following model:

$$\mathrm{Pr}obit(FO)_i = \alpha_0 + \alpha_1 Shareprice_i + \alpha_2 Indexreturns_i + \varepsilon_{it}$$

4 Empirical findings

The empirical analysis consists of two parts. First, we employ bivariate evidence of market returns specific to biotechnology companies, using a probit regression model to test for aggregate market timing. This portion of our analysis is structurally similar to Lerner (1994), in that we focus on whether index returns differ in the quarters before and after IPOs compared to private financings. However, we also go beyond three months and test for differences in index returns over longer periods. In this sense our analysis is similar to Ball et al (2011), who tested for differences in index returns in the four quarters before and after IPO. Second, we conduct bivariate tests of firm-specific returns and index returns to see whether these conditions affect the decision to issue a new equity (also known as follow-on offerings). Using probit we test whether a firm is likely to perform a secondary offering within one and two years post-IPO.

4.1 The timing of financings

In this section, we first examine the timing of financings by venture-backed biotechnology firms. Table 5 and Panel A presents aggregate market returns for all three periods leading up to the event of an IPO or private financing, and after, using the formula:

$$\left(\frac{Current\ index\ level - Original\ index\ level}{Original\ index\ level} \right)$$

Lerner (1994) chose an event window of sixty trading days to be consistent with Mikkelson and Partch (1988), and several other studies. In addition to the event window of sixty trading days before and after IPO, we also examine average returns 90 trading days pre/post-IPO as well as 120 trading days pre/post-IPO. Expanding the event window to 90 and 120 trading days before, and after financing enables more robust testing of the market-timing hypothesis. It is especially interesting to investigate results in the 120 trading day pre/post-IPO as lock-up periods expire six months after an IPO, meaning venture capitalists may begin to exit their positions in the target firm. Since the NASDAQ Biotechnology Index only stretches back to December 12, 1994 we exclude calculations of mean raw returns for those firms who went public less than sixty trading days from the day NASDAQ Biotechnology Index was introduced. The same goes for a certain amount of IPOs that occurred late in 2013, when calculating average returns 90 and 120 trading days post-IPO.

Table 5

Biotechnology equity prices around public and private financings by privately held venture-backed biotechnology companies. The table presents the level of the NASDAQ Biotechnology Index and the mean return froms from biotechnology equities in the three, four and half, and six months before and after the financing.

Panel A: Biotechnology equity prices

		Mean raw "buy-and-hold" return from biotechnology equities around financing date					
Type of financing	Mean level of NBI	Trading days -60 to -1	Trading days 0 to 60	Trading days -90 to -1	Trading days 0 to 90	Trading days -120 to -1	Trading days 0 to 120
191 initial public offerings	1000.14	8.36%	6.61%				
970 private financings	767.57	4.02%	3.19%				
183 initial public offerings	942.09			11.46%	6.94%		
967 private financings	770.53			6.48%	4.40%		
179 initial public offerings	899.48					17.19%	6.59%
967 private financings	766.09					8.34%	6.16%

Panel B: Tests of differences in means and medians

Test	p-value
Wilcoxon rank sum test, median equity index on date of public financing = median equity index on date of private financing	0.00
t-test, mean return in [-60, -1] window before public financing = mean return in [-60, -1] window before private financing	0.055
t-test, mean return in [0, 60] window after public financing = mean return in [0, 60] window after private financing	0.77
t-test, mean return in [-60, -1] window before public financing = mean return in [0, 60] window after public financing	0.013
t-test, mean return in [-60, -1] window before private financing = mean return in [0, 60] window after private financing	0.172
Wilcoxon rank sum test, median equity index on date of public financing = median equity index on date of private financing	0.00
t-test, mean return in [-90, -1] window before public financing = mean return in [-90, -1] window before private financing	0.056
t-test, mean return in [0, 90] window after public financing = mean return in [0, 90] window after private financing	0.525
t-test, mean return in [-90, -1] window before public financing = mean return in [0, 90] window after public financing	0.007
t-test, mean return in [-90, -1] window before private financing = mean return in [0, 90] window after private financing	0.006
Wilcoxon rank sum test, median equity index on date of public financing = median equity index on date of private financing	0.00
t-test, mean return in [-120, -1] window before public financing = mean return in [-120, -1] window before private financing	0.039
t-test, mean return in [0, 120] window after public financing = mean return in [0, 120] window after private financing	0.418
t-test, mean return in [-120, -1] window before public financing = mean return in [0, 120] window after public financing	0.00
t-test, mean return in [-120, -1] window before private financing = mean return in [0, 120] window after private financing	0.004

Raw market returns are calculated for each individual financing event and then aggregated to a total for run-ups and for the respective periods following public or private financings. To test for differences in means and medians, we have computed Two-sample t-tests and Wilcoxon rank-sum (Mann-Whitney) tests. The p-values shown indicate that the differences in means are statistically greater than 0 at the 5% level of confidence.

Mean equity index returns at the time of public financings is 1000.14 compared to 767.5 for private financings for the event window of 60 trading days before and after. For the following two event windows of 90 and 120 trading days, mean index levels decrease to 942.09 and 899.48 for public financings, while 770.53 and 766.09 for private financings, respectively. Using a two-sample mean comparison t-tests and nonparametric Wilcoxon (Mann-Whitney) tests, panel B we see for which return periods the differences are statistically significant at the 5% level of confidence.

On average, an investment in the index increases 8.36% during the event window (-60, -1) prior to an IPO. In comparison, an identical investment at the closing of the IPO date results in an average gain of 6.61%, indicating non-opportunistic market timing. Private financings on the other hand display less clear differences during the three months before (+4.02%) and after IPO (3.19%). Mean returns in the sixty trading days prior to the transaction are significantly greater (about twice the size) than in the sixty trading days before private financings.

In the event window (-90, -1) and (0, +90) investment gains are 11.46% and 6.94% for initial public offerings and 6.48% and 4.40% for private financings. The index return run-up prior to IPO is 3.1% greater than for sixty trading days and only 0.33% greater after. These figures indicate a stronger level of non-opportunistic market timing. In terms of private financings, the differences are smaller as in the first instance and mean returns are roughly twice as high in the period leading up to IPO compared to a private financing.

For an investment made six months before IPO, gains are 17.19% and 6.59% for the next half year. This is a 5.73% increase from the event window of -90 to -1 indicating even stronger non-opportunistic market timing. For an investment made at the day of an IPO and held for the next 120 trading days, gains are 6.59%. This is 0.35% less than for the period 0 to 90 and 0.02% less than 0 to 60. Private financings display greater figures than both other comparative periods. However, raw returns of a public financing 120 trading days prior, is more than twice the size of a private financing (8.85% greater). In the subsequent 120 trading days after a financing event, market returns are almost the same, separated by only 0.43%. This supports the notion that venture-backed issuers are capable of timing the market in a non-opportunistic sense, as a response to market run-ups.

Next we examine these patterns using probit regressions shown in table 6. Observations are financings by privately held firms that have already received venture capital. The dependent variable is set as a dummy variable to indicate whether a firm received public

Table 6

Estimated probit regressions of the decision of privately held venture-backed biotechnology companies to employ public or private financing. The samples consist of 1161, 1150 and 1144 IPOs and private financings between December 12, 1994 and December 31, 2013 by firms that had already received venture capital. The dependent variable is denoted as 1 for IPOs and 0 for private financings. Independent variables consist of three alternative measures of market timing: the level of the NASDAQ Biotechnology Equity Index at the time of financing, and the changes in equity prices in the 60, 90 and 120 trading days before and after the financing.

	Dependent variable: did the firm go public? Model 1		
Probit regression 1	Coef.	dy/dx	P>|z|
Index-level at event	0.0006	0.0001	0.000
Market return -60 to -1	0.2354	0.0567	0.290
Market return 0 to 60	0.1336	0.0322	0.536
y=Pr (Dependentvar) (predict)		0.1574	
Constant	-1.5045		
Log-likelihood	-498.7384		
Pseudo R2	0.0391		
Number of observations		1161	

	Dependent variable: did the firm go public? Model 2		
Probit regression 2	Coef.	dy/dx	P>|z|
Index-level at event	0.0005	0.0001	0.000
Market return -90 to -1	0.1588	0.0378	0.358
Market return 0 to 90	0.1118	0.2659	0.599
y=Pr (Dependentvar) (predict)		0.1546	
Constant	-1.4198		
Log-likelihood	-491.8705		
Pseudo R2	0.024		
Number of observations		1150	

	Dependent variable: did the firm go public? Model 3		
Probit regression 3	Coef.	dy/dx	P>|z|
Index-level at event	0.0004	0.0001	0.000
Market return -120 to -1	0.3439	0.0805	0.045
Market return 0 to 120	0.1051	0.0246	0.585
y=Pr (Dependentvar) (predict)		0.1507	
Constant	-1.3883		
Log-likelihood	-483.1337		
Pseudo R2	0.0197		
Number of observations		1144	

The number of observations decrease between datasets due to the event windows stretching beyond what is available of information from the NASDAQ Biotechnology Equity Index. The last update to the index in this study was done on April 30, 2014

or private financing, where 1 denotes IPO and 0 a private financing. Independent variables are three measures of timing; the value of the NASDAQ Biotechnology Equity Index at the time of financing, the raw market returns from an investment in biotechnology securities in the periods leading up to the financing, and raw market returns in the periods after the financing.

In the first regression model, the marginal effects and coefficients of the index-level at the event of an initial public offering or a private financing are statistically significant at the 5% level of confidence. However, these figures are so low that their impact on the decision to go public is contestable. Market returns -60 to -1 shows a higher marginal effect (0.057) and coefficient (0.235), boosting the chance of an IPO, but is not significant at the 95% confidence interval. Market returns 0 to 60 are not significant (p-value > 0.05), ruling out its effect on the prospect of IPO. Thus, these variables are not significant in explaining the decision to go public, and reject our hypothesis that a higher level of the equity index increases the probability of a public financing.

In model number two, we expand the event window to 90 trading days before and after financing to see if there is any correlation over a longer time span. The probit model yields more or less the same results as in model 1. Both marginal effects and coefficients are smaller for all three variables (except for the third one), whereas the p-values of raw market returns before and after the event are greater.

For probit regression number three, we further expand the event window to six months. Index levels at the event of financing remain low, yet statistically significant. However, unlike the previous two models, increases in equity values in the six months prior to the financing boost the chance of an IPO (the coefficient of 0.344 and marginal effect of 0.08). The results are significant at the 5% level of confidence and indicate that venture capitalists can time the market. However, with that being said, we find no support for the market-timing hypothesis – i.e. that issuers are more prone to go public when investors and the market are overoptimistic, such that ensuing market returns are negative. What we do find support for is evidence of pseudo market-timing as demonstrated by Schultz (2003). He showed that the decision to go public is a response to current price levels and is not made because future returns are predictable. Accordingly, as Ball et al (2011) propose, IPO waves and the propensity to go public are explained by market conditions can be termed pseudo market-timing as well[11].

Lastly, when looking at Pseudo R2 values (goodness-of-fit measure), we see that the values are very low, meaning there are possibly other independent variables that can better explain the decision of venture capitalists to take a portfolio company public.

[11] Pastor and Veronesi (2005) constructed a model devoid of opportunism, in which IPO volume depends on fluctuations in market conditions. IPO waves develop in a rational way, with IPO volume more tied to recent changes in stock prices than to price levels. Their model predicts IPO waves that are preceded by higher returns and subsequently by lower returns.

4.2 The timing of follow-on offerings

In the following analyses we study the timing of follow-on offerings by formerly venture-backed biotechnology companies that occur in the first and second year after the initial public offering. Observations are equity-issues and non equity-issues by public firms that were received venture capital when they were privately held. To calculate firm-specific returns between two days after IPO until one day before the announcement of the follow-on offering (or non follow-on offering), we use the following formulas:

$$\left(\frac{Current\ shareprice - Original\ shareprice}{Original\ shareprice} \right)$$

$$\left(\frac{Current\ index\ level - Original\ index\ level}{Original\ index\ level} \right)$$

We choose to look at firm-specific returns two days post-IPO and one day prior to the follow-on offering announcement, to account for any changes in shareprices that could be a result of underpricing at IPO and negative market reactions to announcement news of a follow-on offering. We look at the timing of new equity issues in relation to the timing of initial public offerings, as a way of bringing in new capital to the target firm and as the next step in the process of facilitating an exit for the venture capitalists. Table 7 displays the results of the probit models for hypothesis 2.

Table 7

Estimated probit regressions of the decision of public and formerly venture-backed biotechnology companies to issue new equity or not. The sample consists of 179 issuing and non-issuing firms, between the December 12th, 1994 and April 21st, 2014. The dependent variable is denoted as 1 for follow-on offerings and 0 for those who refrain. Independent variables consist of two alternative measures of market timing: the firm specific equity prices between 2 days post-IPO and 1 day before the announcement of a follow-on offering, and the changes in market returns during the same period.

	Dependent variable: did the firm issue new equity? Model 1		
Probit regression 1	Coef.	dy/dx	P>|z|
Firm specific returns 2 to -1	1.0084	0.1943	0.00
Market return 2 to -1	1.0547	0.2032	0.049
y=Pr (Dependentvar) (predict)		0.1138	
Constant	-1.4598		
Log-likelihood	-59.4646		
Pseudo R2	0.2186		
Number of observations		179	
	Dependent variable: did the firm go public? Model 2		
Probit regression 2	Coef.	dy/dx	P>|z|
Firm specific returns 2 to -1	0.9017	0.2342	0.00
Market return 2 to -1	1.5176	0.3941	0.001
y=Pr (Dependentvar) (predict)		0.1771	
Constant	-1.2416		
Log-likelihood	-73.5799		
Pseudo R2	0.2049		
Number of observations		179	

The number of equity-issuing firms increases from 27 to 38 between datasets as we expand the time horizon from one to two years. Concurrently, the number of non equity-issuing firms decreases from 152 to 141.

We set the dependent variable as a dummy to indicate whether a company completed a follow-on offering or not, denoting equity-issue as 1 and non-equity issue as 0. Independent variables are two measures of timing; the firm specific share prices in the period between IPO and follow-on, and raw index returns during the same period. By setting these two as independent variables, we examine the timing of follow-on offerings up against firm-specific developments and index-level developments.

In model 1, where the time horizon is one year, index returns 2 to -1 display higher marginal effects than firm specific returns 2 to -1 (0.2032 compared to 0.1943). Both are statistically significant at the 5% level of confidence. When we expand the time period to two years in model 2, the number of companies in our sample who issue new equity increases from 27 to 38 while the number of non-issuers decreases from 152 to 141. Total sample size

stays the same at 179 in both regressions. Marginal effects for index returns 2 to -1 remain higher than those of firm specific returns 2 to -1 (0.3941 versus 0.2342), and are statistically significant. Our findings indicate that developments in index returns also have a significant impact on the decision to issue a follow-on offering, rather than only developments in firm-specific returns. This suggests that there is a correlation between the timing of IPOs by venture-backed biotechnology firms and the timing of follow-on offerings. Finding evidence supporting pseudo-market timing in our models from hypothesis 1, our results in hypothesis 2 point to that venture capitalists consider the prospect of follow-on offerings when deciding whether or not to take a firm public.

5 Conclusion

This chapter briefly summarises major findings of the study and discusses the implications of these findings. At the very end we provide some suggestions for further research.

In this paper we have investigated the ability of venture capitalists to time market conditions when deciding between public and private financings as well as issuance of follow-on offerings, focusing on a segment of the U.S. biotechnology industry. This has been assessed by studying the timing of public vs. private financings measured against market conditions during and around the time of financings.

Using probit models, we find evidence of pseudo market-timing, meaning that the decision of venture capitalists to take a company public is a response to market sector run-ups, not because future market returns are predictable. Further, when examining financing events post-IPO, our models show that there is significant correlation between firm-specific returns and market sector run-ups, and the prospect of issuing new equity within one and two years post-IPO.

Successful timing, as discussed in earlier chapters, brings about significant benefits to venture capitalists despite evidence that they seldom sell shares at the time of the initial public offering (Barry et al., 1990 and Megginson and Weiss, 1991). The fact that venture capitalists are willing to bind themselves to the value of the company they are taking public by holding their equity positions beyond IPO, strengthens the argument that IPOs merely facilitate the process of a venture capitalist's exit.

Like leveraged buyout specialists, venture capitalists eventually seek to dismantle their ownership position. The objective of the leveraged buyout specialist is to oversee and drive through efficient restructuring of operations to turn around mature companies. As soon as this has been successfully completed, the specialist seeks new opportunities in which it can redeploy its resources to gain from higher marginal productivity (DeAngelo and DeAngelo, 1987). In a similar vein, the expertise of venture capitalists is to guide entrepreneurial ventures in early growth stages, until they mature and it becomes rational to leave their portfolio firms.

Since equity capital is the primary source of funding for biotechnology companies in early stages, the timing of IPOs and follow-on offerings is significant. Successful timing of both IPOs and later public offerings finances investments and development, increasing the potential value of the firm, which in turn could increase the equity position of the venture capitalist. Based on our empirical findings, it appears that venture capitalists operating in the

biotechnology industry, can time the market. This is argued from the perspective of IPOs and follow-on offerings as facilitating mechanisms for venture capitalists in the process of exiting their equity positions and realising returns on investment.

However, focusing on a single industry, particularly the U.S. biotechnology industry with its unique characteristics, limits the generalisation of our findings. We further acknowledge that the absence of control variables in our econometric models may weaken our findings. Future studies could address this issue as well as include variables omitted from our study that have the potential to better explain the decisions of venture capitalists to take companies public. Furthermore, investigating how venture capital has developed over the past decades (e.g. regulatory changes), and how such developments have affected the methods by which venture capitalists operate, may bring new discoveries to the surface.

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7 Appendix

The private financing dataset – no exit

Here the dataset consists of 273 biotech firms who have received venture capital financing but that have yet to perform an exit during the same time period, meaning they were still venture-backed by the end of 2013. In the data extracted from Thomson One, not all investment rounds disclose the invested amount. Therefore those investment rounds missing a dollar figure have been excluded from the dataset in order to keep the sample as undistorted as possible (the number of discarded rounds are shown). In total there were 910 investment rounds between Jan 1st 1993 and Dec 31st 2013 divided among the 273 firms.

The acquisition dataset

Since an IPO is not the only form of exit for a venture capital firm a third dataset is included in the sample, comprised of formerly venture-backed biotechnology companies that were acquired by a third party during the same previously mentioned period. Similarly to the IPO dataset the number of acquisitions each year are listed, together with total deal values, average and median as well as the average number of investment rounds pre-acquisition. It is worth mentioning that the number of firms that have merged and been acquired is in fact much greater than 118. However, as deal terms often remain undisclosed we have only included those cases where deal value and the name of the acquirer were mentioned in the Thomson database or could be found online.

NASDAQ Biotechnology Index Security Eligibility Criteria

To be eligible for inclusion in the Index, a security must be listed on the NASDAQ Stock Market and meet the following criteria:

- The security U.S. listing must be exclusively on the NASDAQ National Market (unless the security was dually listed on another U.S. market prior to January 1, 2004 and has continuously maintained such listing);
- The issuer of the security must be classified according to the Industry Classification Benchmark as either Biotechnology or Pharmaceuticals;
- The security may not be issued by an issuer currently in bankruptcy proceedings;
- The security must have a market capitalization of at least $200 million;
- The security must have an average daily trading volume of at least 100,000 shares;
- The issuer of the security may not have entered into a definitive agreement or other arrangement which would likely result in the security no longer being Index;
- The issuer of the security may not have annual financial statements with an audit opinion that is currently withdrawn; and
- The issuer of the security must have "seasoned" on NASDAQ or another recognized market for at least 6 months; in the case of spin-offs, the operating history of the spin-off will be considered.

* For the purposes of Index eligibility criteria, if the security is a depositary receipt representing a security of a non-U.S. issuer, then references to the "issuer" are references to the issuer of the underlying security.

Semi-annual Ranking Review

The Index Securities are evaluated semi-annually as follows. Securities currently within the Index must meet the maintenance criteria of $100 million in market capitalization and 50,000 shares average daily trading volume. Index securities not meeting the maintenance criteria are retained in the Index provided that such security met the maintenance criteria in the previous semi-annual ranking. Securities not meeting the maintenance criteria for two consecutive rankings are removed. Index-eligible securities not currently in the Index are added. Changes will occur after the close of trading on the third Friday in May and November. The data used in the ranking includes end of March and September NASDAQ market data and is updated for total shares outstanding submitted in a publicly filed SEC document via EDGAR through the end of April and October.

In addition to the Ranking Review, the securities in the Index are monitored every day by NASDAQ with respect to changes in total shares outstanding arising from secondary offerings, stock repurchases, conversions, or other corporate actions. NASDAQ has adopted the following weight adjustment procedures with respect to such changes. Changes in total shares outstanding arising from stock splits, stock dividends, or spin-offs are generally made to the Index on the evening prior to the effective date of such corporate action. If the change in total shares outstanding arising from other corporate actions is greater than or equal to 5.0%, the change will be made as soon as practicable, normally within ten (10) days of such action. Otherwise, if the change in total shares outstanding is less than 5%, then all such changes are accumulated and made effective at one time on a quarterly basis after the close of trading on the third Friday in each of March, June, September, and December. In either case, the Index share weights for such Index Securities are adjusted by the same percentage amount by which the total shares outstanding have changed in such Index Securities.