Article

Leaving Money on the Table in Venture-Backed biotechnology IPOs

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ABSTRACT

This study analyzes first-day returns (underpricing) for venture-backed biotechnology IPOs during 1980 through 2015. The result of this study shows that the average first-day return was 17.5 percent, which translates into an amount equal to $6.3 billion that was left on the table - nearly triple the $2.2 billion in underwriter fees. The study provides different theoretical explanations to the underpricing phenomenon and discusses why venture capitalists may be willing to accept leaving money on the table. The analysis also shows that IPOs with a large degree of underpricing are concentrated in hot IPO markets such as during 1999-2000 and more recently in the years 2014-2015. Notable, eight of the thirteen venture-backed biotechnology IPOs with the largest amount of money left on the table in the history of biotechnology went public during 2014-2015. From an investor perspective, if the degree of underpricing is an indicator of a pricing bubble, as was the case in 1999-2000, rational investors should at least be a little bit concerned about the state of the biotechnology equity market. From a management and venture capitalist perspective, issuing firms should at least consider using auctions as opposed to book-building to price and allocate IPOs to decrease the degree of underpricing and thereby the amount of money left on the table.

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INTRODUCTION

Going public represents a major milestone in the lifecycle of a young venture. It provides access to the major source of public equity capital, which often is required to fund clinical trials and bring product candidates close to market launch. It also allows the existing investors to have a liquid market for their shares and enabling them to realize their capital gains from backing the company – a key consideration for venture capitalists.

When companies go public, the shares that are sold tend to be underpriced, in that the share price jumps on the first day of trading. In Genentech's initial public offering (IPO) on October 14, 1980, the first-day return was 103.6 percent. More recently, Dicerna Pharmaceuticals and Seres Therapeutics, which both went public in 2015, had first-day returns of 206.7 percent and 185.6 percent, respectively. However, underpricing is costly because it transfers wealth from preexisting shareholders (including the venture capitalists) to new shareholders. The newly issued shares are sold at an excessively low price, whereas the value of the shares that are retained is diluted. What explains the underpricing phenomenon? Why are venture capitalists willing to incur this cost and thereby leave money on the table?

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MONEY LEFT ON THE TABLE

During 1980-2015, a total of 567 venture-backed biotechnology companies went public in the United States raising $31.0 billion in gross proceeds. These firms had an average first-day return (or 'underpricing discount') of 17.5%. This first-day return translates into an amount equaling $6.3 billion that was left on the table, defined as the number of new shares sold times the difference between the first-day closing price and the IPO price. If the shares had been sold at the closing price rather than the IPO price,

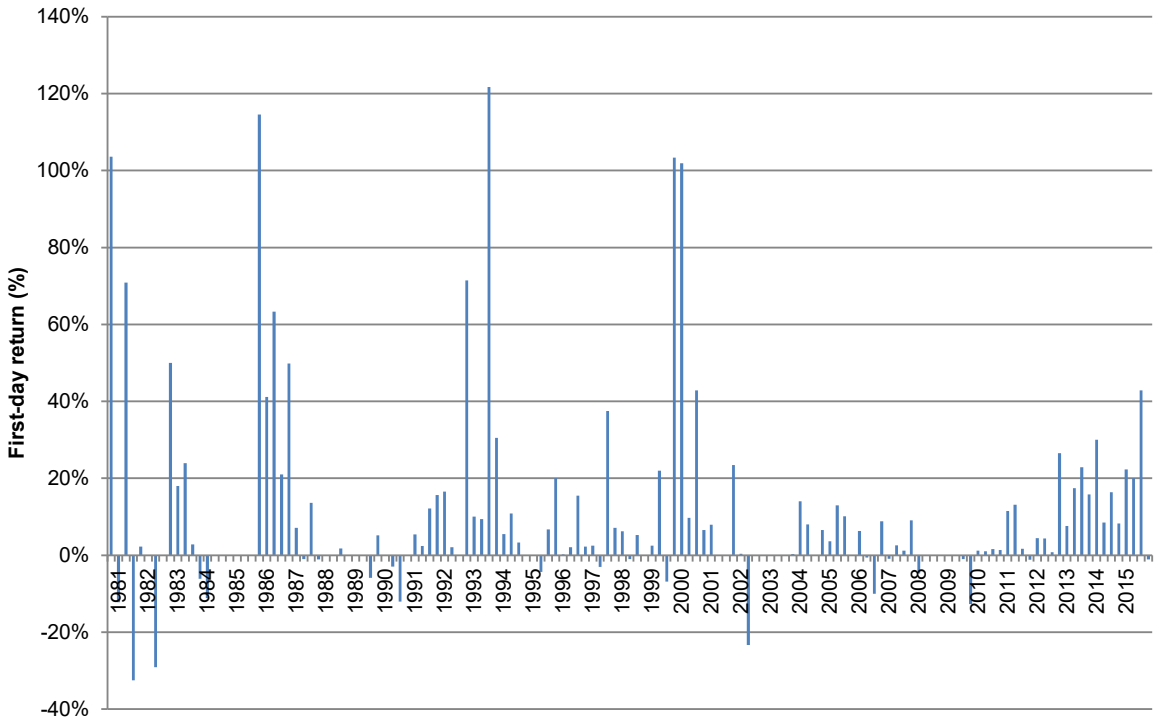


Figure 1: IPO underpricing of U.S. venture-backed biotechnology companies, 1980–2015
Initial IPO returns for venture-backed biotechnology firms in the United States, 1980-2015. The figure reports quarterly equal-weighted average initial IPO returns in % for 567 IPOs completed in the United States between 1980 and 2015, calculated as the first-day closing price over the IPO offer price less one. The data is based on 567 VC-backed biotechnology companies with SIC industry sector codes 2833-2836 (Drugs) and 8731 (Commercial Physical and Biological Research). The list does not include venture-backed IPOs in Medical/Health (e.g. SIC code 384) or related sectors. For details, see Supplemental Appendix 1.

the firm could raise more money by an amount equal to the money left on the table. Alternatively, the same proceeds could have been raised by issuing fewer shares, resulting in less dilution of the preexisting shareholders.

To put figures into perspective, the $6.3 billion left on the table is nearly triple the $2.2 billion in fees to the underwriter paid by the issuing companies (which seems to be fixed at 7% of the gross proceeds). In addition to the direct investment banker fees, there is indirect compensation to underwriters: they typically have overallotment options that entitle the underwriter to purchase additional shares (usually 15% of the offer size) from the issuer at the IPO price less the underwriting discount.

The extent of underpricing tends to fluctuate a great deal across firms and over time. During hot issue markets, such as the genomics bubble of 1999-2000, huge amounts of money were left on the table (see Figure 1). In Q4 1999 and Q1 2000, the level of underpricing averaged at 103.3 percent and 101.9 percent, respectively. In dollar terms, issuers left an aggregate of $1.1 billion on the table in those two quarters alone. More recently, during the current IPO window, the underpricing discount averaged 42.9 percent in Q3 2015.

There is also a great deal of variation across firms. For example, when Genentech went public in October, 1980, with Blyth Eastman Paine Webber and Hambrecht & Quist as underwriters, 1 million shares (excluding the over-allotment option to underwriters) were sold to investors at $35 per share raising $35 million before underwriter fees. Shares of Genentech almost tripled in the first few minutes of trading and closed at $71.25 at the end of the first day at a total market value of $262 million. The first-day return, calculated as the percentage change from the IPO price to the first-day closing price, was 103.6 percent. The money left on the table, calculated as the difference between the first-day closing price and the IPO price multiplied by the number of shares offered, was $36.3 million: ($71.25 – 35) × 1.0 million shares = $36.3 million.

Who benefited from this underpricing? Who lost from the price increase? New investors who were lucky enough to obtain any of the newly issued shares at the IPO price of $35 saw an instant return of 103.6 percent

on their investment – a great one day performance. To the extent that the investors who were able to be allocated shares in the IPO have other relationships with the investment banks, the investment banks may benefit indirectly from the IPO deal through their future business with these clients. Preexisting investors (e.g. venture capitalists) of the other shares outstanding that were not sold as part of the IPO had a wealth gain on the retained shares. But who lost? Selling shareholders lost (there where however no selling shareholders in Genentech's IPO), because they sold the stock for only $35 per share when the public market was willing to pay $71.25 per share. In addition, preexisting shareholders lost at the same time because the value of their shares retained was diluted. In Supplemental Appendix 2, I return to the current example and show how the underpricing translates into wealth losses (a dilution cost) for the preexisting shareholders. As shown in that section, preexisting shareholders made a loss of $5.60 per old share (dilution cost), which on the basis of 6,472,102 shares prior to the IPO translates into an amount that is equal to the money left on the table, i.e. $36.3 million.

Table 1 displays a list of VC-backed biotechnology IPOs sorted on the highest level of amount of money left on the table. Initial public offerings with the highest degree of first-day returns tend to occur in 'hot' issue periods, so called IPO windows. These biotechnology IPO windows have been described by several practitioners and industry observers and occurred in 1983, 1986–1987, 1991–1992, 1995–1998, 2000–2001, 2003–2007, and more recently in 2014–2015.[1-6] The majority of issuers in Table 1 took place in 1999-2000 or 2014-2015. Diversa, which went public in the midst of the genomics bubble of 2000, had a first day return of 212.5 percent, which translated into leaving $369.8 million on the table. Notable, eight of the thirteen VC-backed biotechnology IPOs with the largest amount of money left on the table went public during 2014–2015.

Why are venture capitalists 'accepting' leaving considerable amounts of money on the table? To gain an understanding why IPOs on average need to be underpriced, and alternative explanations to the underpricing phenomenon it may be good to start with introducing the parties involved in the IPO.

ASYMMETRIC INFORMATION AND THE LEMONS PROBLEM

An IPO transaction has a series of parties involved in the process: The issuing firm, the preexisting investors (including the venture capitalists), the investment banks underwriting and marketing the deal, and the new outside investors. Asymmetric information models of IPO underpricing assume that there is asymmetric information either between informed and uninformed investors or between corporate insiders and public investors, and that the resulting information frictions give rise to underpricing in equilibrium.[7-8] For example, if some investors (e.g. specialist healthcare investors) are better informed than others (e.g. generalist investors) about a firm's true value they can avoid participating in overvalued IPOs. Unfortunately, this gives rise to a so called 'lemons problem' – uninformed investors are allocated overpriced IPOs.[9] Therefore, this has to be countered by deliberate underpricing, otherwise the market for IPOs would entirely collapse if uninformed investors were only allocated overpriced IPOs. In addition, venture capitalists have to be concerned about their reputation if they seek to be active long-term players and retain access to the IPO market. Since venture capitalists are recurrent players in the IPO market there are strong *a priori* reasons to believe that they do not bring overpriced IPOs to the market.

Oftentimes when there is a large stock price-run-up, the IPO price has been increased above the original file price range (see Figure 2). The size of the difference is large: issues where the final IPO price is below the file price range have average first-day returns of 9.4%, whereas those that are priced above the file price range have average first-day returns of 63.7% (and those that are price within the range have an average first-day return of 14.1%). The positive correlation between price revision over the course of book-building and the first-day return is often referred to as the 'partial-adjustment' phenomenon.[10] The underwriter rewards institutional investors for honestly revealing their willingness to purchase shares at a high price by larger allocations. But the positive association between first-day returns and price revisions indicate that when the offer price is increased in response to potential strong demand, the price could have been increased even more. Increasing the price does, however, not come for free. The underwriter needs to balance the gain from a higher stock price with the extra expenses associated with greater marketing effort.

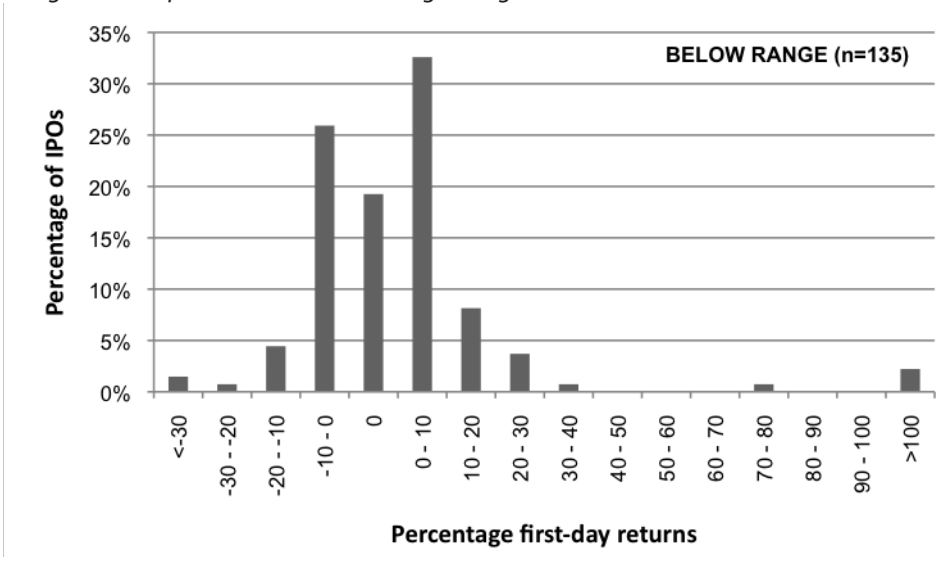
As underpricing represents an involuntary cost to the issuer, there are clear incentives to reduce the information asymmetry and the resulting adverse selection problem. One way to reduce the information asymmetry is to hire a high-ranked underwriter or a reputable auditor. These third-party intermediaries certify the quality of the issue by agreeing to be associated with the offering. Underwriting fees are typically proportional to IPO proceeds, and thus inversely related to underpricing. This provides a countervailing motivation to keep underpricing low. However, advocates of the agency view stress the self-interested nature of investment banks. In other

Table 1: IPO underpricing and money left on the table in venture-backed biotechnology IPOs

Company	IPO date	Amount raised ($mil)	Post-money valuation ($mil)	Underpricing (%)	Money left at the table ($mil)	Bookrunner(s)	Venture capitalists
Diversa	02-14-2000	174.0	793.1	212.5	369.8	Bear Stearns	HealthCare Ventures, Patricof & Co. Ventures, Rho Ventures
Sequenom	02-01-2000	136.5	593.9	204.8	279.6	Warburg Dillion Read	TVM Techno Venture Management, Alpinvest International B.V., Lombard Odier & Cie
Seres Therapeutics	06-26-2015	133.7	681.0	185.6	248.2	Goldman Sachs, Merrill Lynch Pierce Fenner & Smith	Flagship Ventures, Enso Ventures 2 Limited
Spark Therapeutics	01-30-2015	161.0	540.3	117.4	189.0	Credit Suisse, J.P. Morgan	Sofinnova Ventures
Dicerna Pharmaceuticals	01-30-2014	90.0	249.4	206.7	186.0	Jefferies, Leerink Swann, Stifel Nicolaus	Domain Associates, Skyline Ventures, Abingworth Bioventures
Aduro Biotech	04-15-2015	119.0	1,002.2	147.1	175.0	Leerink Swann, Merrill Lynch Pierce Fenner & Smith	Morningside Venture Investments, Johnson & Johnson Development Corporation
Maxygen	12-16-1999	96.0	478.6	162.9	156.4	Goldman Sachs	Technogen Associates
Global Blood Therapeutics	08-12-2015	120.0	556.2	115.6	138.7	Morgan Stanley, Goldman Sachs	Third Rock Ventures
Illumina	07-28-2000	93.0	500.1	144.8	136.1	Goldman Sachs	CW Group, ARCH Venture Partners, Venrock, TGI Fund
Ultragenyx Pharmaceutical	01-31-2014	121.0	610.3	101.2	122.4	J.P. Morgan, Morgan Stanley	TPG Biotechnology Partners, Beacon Bioventures, HealthCap, A.M. Pappas Life Science Ventures
Juno Therapeutics	12-19-2014	264.6	1,870.5	45.8	121.3	Goldman Sachs, J.P. Morgan, Morgan Stanley	CL Alaska L.P. and JT Line Partners L.P., ARCH Venture Partners
ProNAi Therapeutics	07-16-2015	137.7	490.1	81.2	111.8	Jefferies, Merrill Lynch Pierce Fenner & Smith	Vivo Ventures, Frazier Healthcare, Orbimed, Adams Street Partners
Foundation Medicine	09-25-2013	106.0	489.1	96.4	102.2	Goldman Sachs, J.P. Morgan	Third Rock Ventures, KPCB, Google Ventures, Gates Ventures

The list only include venture capitalists with a five percent (or more) ownership prior to the IPO (as detailed in the IPO prospectus). I acknowledge that some VCs own less than five percent prior to the IPO, but are not credited in this list. The list does not include other large pre-IPO investors, such as mutual funds, hedge funds, corporations, private investors or foundations. Post-money valuation, defined as the total number of shares outstanding after the IPO times the IPO price, excludes the value of the over-allotment option.

a. IPO underpricing and offer price revisions below target range



b. IPO underpricing and offer price revisions in the target range

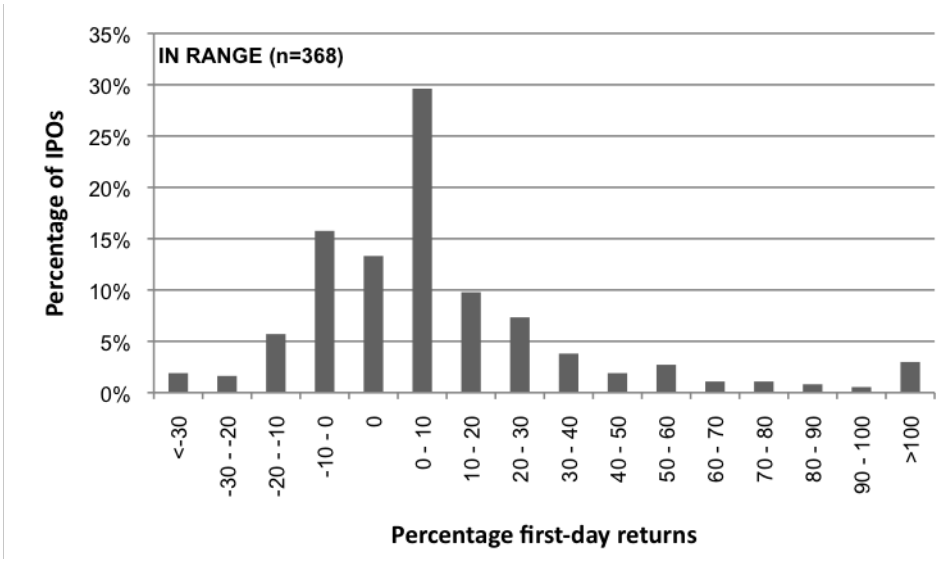


Figure 2: Offer price revisions and IPO underpricing
The figures display the distributions of first-day returns when the final offer price is: 1) below the initial price target range (a), 2) within the target range (b), and 3) above the target range (c). The dataset is based on 555 venture-backed biotechnology IPOs with available initial filing price range information

words, it is possible that the investment bank's private benefits of underpricing greatly exceed this implied loss of underwriting fees, which may cause agency problems between the issuing firm and the investment bank. For example, the underwriting investment banks may accept side-payments (e.g. excessive trading commissions paid on unrelated transactions) from investors competing for allocations of underpriced stock. In practice, investment banks repeatedly deal with institutional investors, but infrequently with issuers.

While the empirical evidence supports the view that asymmetric information models, including agency conflicts between the issuer and the investment banks, provides a primary explanation to the why new issues are underpriced, the enormous fluctuation in the level of underpricing over time raises doubt whether there may be other reasons that may explain the underpricing

c. IPO underpricing and offer price revisions above target range

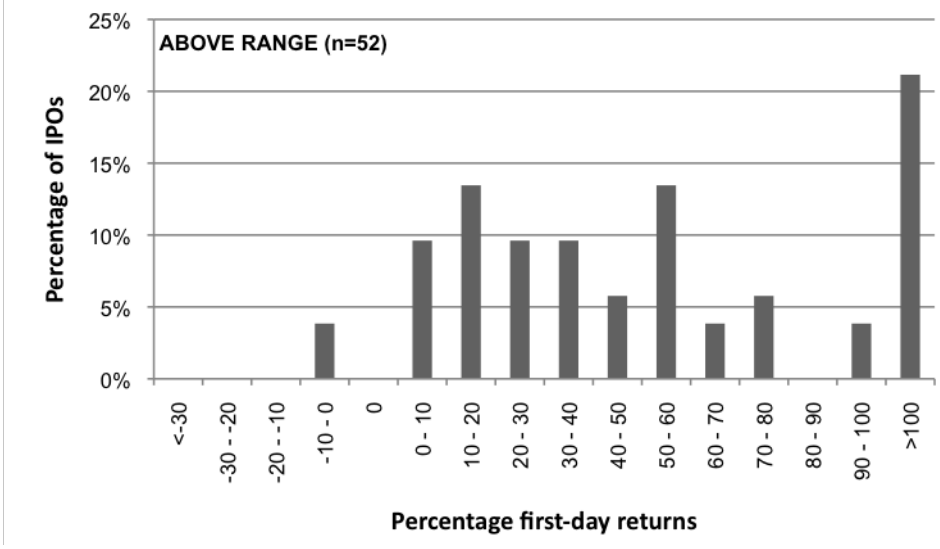


Figure 2: Continued

phenomenon. The next sections describe some alternative explanations.

ABSOLUTE VERSUS RELATIVE CHANGE IN WEALTH

A reason why venture capitalists fail to 'get upset' about leaving millions of dollars on the table in the form of large first-day returns because they focus on the change in their wealth instead of the level of wealth. As suggested by prospect theory, they tend to sum the wealth loss due to underpricing with the (sometimes larger) wealth gain on retained shares from the increase in share price, producing a net increase in wealth for preexisting shareholders.[11-12] In other words, by integrating the loss with the gain, the venture capitalists are left satisfied and are pleased with the IPO underwriter's performance at the IPO, even though they have just been victimized. An example will demonstrate the argument.

In Genentech's IPO, co-founders Herbert Boyer and Robert Swanson each held 925,000 shares. Prior to going public, Genentech filed a preliminary prospectus with the Securities and Exchange Commission (SEC). According to the prospectus, a price range of $25-30 per share and sales of 1 million shares was expected. The expected value of their shares, based upon the mid-point of the filing price range, equaled $25.4 million, respectively, at the time that the preliminary prospectus was filed. However, the IPO priced at $35 per share, above the expected price range of $25-30. The expected value of their respective Genentech holdings was worth $32.4 million. In the first few minutes of trading, the shares increased from $35 to $85, which, at the time, was the largest gain in stock market history (for a newly listed company). The shares closed at $71.25 at the end of the day, a 103.6 percent increase over the first day and valuing the company at $262 million. At the end of the first day of trading the value of their shares now equaled $65.7 million, respectively, a 258% increase of their pretax wealth over only a few weeks. So at the same time that they learned that they had been diluted more than necessary because of the large amount of money left on the table, they discovered that their wealth had increased by more than $40 million. Would many people be disappointed?

While Genentech's IPO made headlines around the world and demonstrated to venture capitalists that an investment in biotechnology could achieve liquidity within a timetable of four years even if the company had no product or sales revenues not everyone were happy. The chairman of the board and venture capitalist Tom Perkins (Kleiner Perkins) was reportedly incensed that the underwriting banks failed to issue enough stock and left many additional millions on the table.

GRANDSTANDING – ACT WITH A VIEW TO IMPRESS ONLOOKERS

Empirical research on the performance of mutual funds and hedge funds suggests that past performance is a strong predictor for attracting future investors.

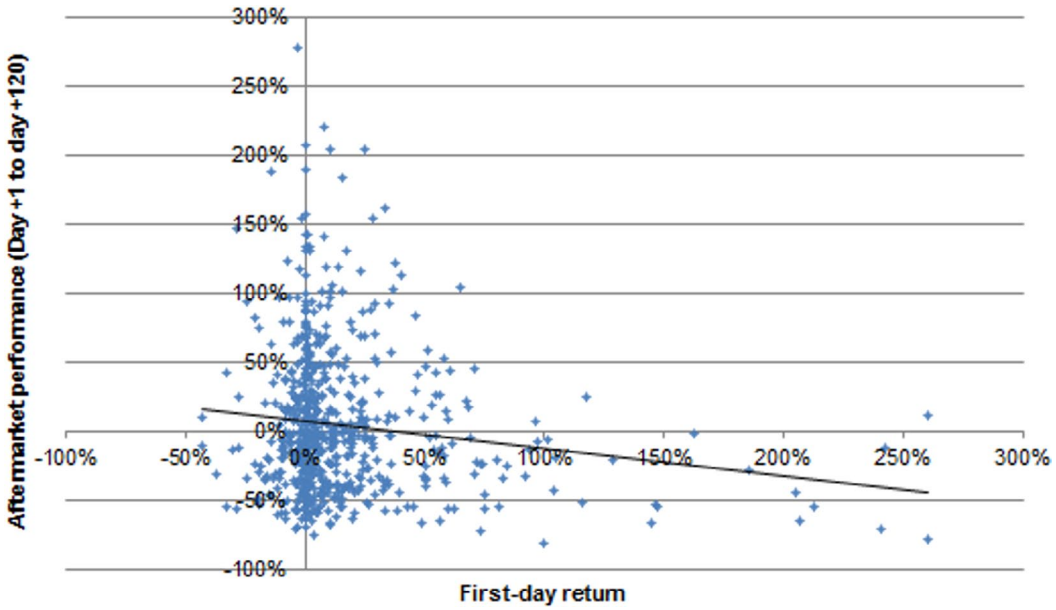


Figure 3: *Aftermarket performance and first-day return. The figure displays the association between first-day return and aftermarket performance (from day +1 to day +120 relative to the IPO date). The dataset is based on 567 venture-backed biotech IPOs.*

Although VC firms can realize returns through acquisitions as well as IPOs of their portfolio firms, IPOs generally also bring considerable media interest and spotlight on the company compared to many private acquisitions. Establishing a reputation as a VC firm that is capable of taking portfolio companies public (or sell them for attractive multiples privately) is critical to future fundraising. Young venture capital firms need to establish a reputation in order to successfully raise capital for follow-on funds. In contrast, old established venture capital firms do not need to signal, because investors have evaluated their performance over many years and believe in their ability. Hence, young venture capital firms without a track-record may therefore *grandstand* - they take portfolio companies public earlier than would maximize the return on those individual companies and at the same time accept greater underpricing than would older and more experienced venture capital firms.[13]

The relation between reputation and fundraising is also consistent with general industry wisdom. Established venture capital firms with long track-records raise large funds quickly and with little effort. When New Enterprise Associates, one of the oldest and most prestigious firms, began their 15th venture fund in January 2015, they raised more than $2.8 billion (excluding the co-investment fund of $350 million) and closed the fund by April in an over-subscribed fund ($2.5 billion had originally been targeted). In contrast, venture capital firms in their first fund who have shown no returns may find it difficult to raise new money, despite having a line-up of Noble Laureates associated with the fund. These firms may have strong incentives to grandstand. Two young venture capital firms, Third Rock Ventures and The Column Group, yet already well-respected within VC circles following outstanding performance of each of their first fund provide two examples.[14] Third Rock Ventures formed its first venture capital fund in 2007 raising $378 million in committed capital. In 2013, they brought their first three portfolio firms public; bluebird bio in June (first-day return of 58.3 percent), Agios Pharmaceuticals in August (73.8 percent), and, Foundation Medicine in September (96.4 percent). In September the same year they raised an oversubscribed $426 million second fund. The Column Group took a different route to raising their second fund. They started the first fund in 2007 at $260 million. The venture firm considered raising a second fund in the spring 2010, but decided against it as they wanted to have a couple of spectacular exits.[15] After two high-profile billion dollar acquisitions of two young portfolio firms, Aragon Pharmaceuticals and Seragon Pharmaceuticals, in June 2013 and in July 2014, respectively, they closed their second fund in October 2014 at $322 million.

Table 2 lists some of the most experienced VC firms as measured by the number of biotechnology issues (but excludes Medical/Health and other sectors) brought to market over the period 1980-2015. As expected, the list is dominated by venture players that were established in the 1970s and 1980s.

Table 2: List of venture capitalists bringing 16 or more U.S. biotechnology issues to market over the period of 1980–2015

Venture capital firm	Founded (Year)	Total capital under management ($m)	Number of biotechnology portfolio companies invested in	Total equity invested in biotechnology firms ($m)	Number of U.S. biotechnology IPOs
Domain Associates	1985	2,600	147	1,609	47
New Enterprise Associates	1977	14,000	120	1,388	37
Venrock	1969	2,000	79	810	36
Alta Partners	1996	2,000	94	1,137	34
Kleiner Perkins Caufield and Byers	1972	3,400	79	875	33
MPM Capital	1996	2,581	100	1,296	32
Hambrecht & Quist Venture Partners (Pliant Corp)	1984	*	88	538	29
Sofinnova Ventures	1974	1,000	65	793	28
OrbiMed Advisors	1989	15,000	99	958	26
ARCH Venture Partners	1986	1,900	68	631	19
Johnson & Johnson Development Corporation	1973	N/A	71	450	19
TVM Capital	1983	1,376	77	552	19
Abingworth Management	1973	1,800	77	570	18
Canaan Partners	1987	3,500	49	404	18
Aisling Capital	2000	1,600	32	413	17
Flagship Ventures	2000	929	59	624	17
Versant Ventures	1999	1,900	57	826	17
Polaris Venture Partners	1996	3,500	49	635	16

*List of venture capitalists bringing 16 or more U.S. biotechnology issues to market over the period 1980-2015. There are 200 additional venture capitalists that are involved in at least 4 offerings. The data is based on 567 VC-backed biotechnology companies with SIC industry sector codes 2833-2836 (Drugs) and 8731 (Commercial Physical and Biological Research). The list does not include venture-backed IPOs in Medical/Health (e.g. SIC code 384) or related sectors. For details, see Supplemental Appendix 1. *JP Morgan Partners (Pliant Corp) had $25 billion assets under management as of 12/31/2003.*

There are, however, some notable examples of highly underpriced IPOs backed by experienced VC investors. For example, Dicerna Pharmaceuticals, which went public in January 2014 with a first-day return of 206.7 percent, was backed by reputable venture investors (Domain Associates, Skyline Ventures and Abingworth Management) with Jefferies as the lead underwriter. Furthermore, Spark Therapeutics, which went public on January 30, 2015 had a first-day return of 117.4 percent, was backed by the experienced VC firm Sofinnova Ventures with Goldman Sachs as the lead underwriter. The question from these examples is why also experienced venture capital firms, and ultimately limited partners (LPs), 'accept' leaving considerable amount of money on the table?

LEAVE A GOOD TASTE IN INVESTORS' MOUTHS

Venture capitalists have several mechanisms to assure that their portfolio firms go public when they perceive as optimal. Venture investors usually hold several board seats and powerful control rights. As informal advisors to managers, they usually have experienced many more IPOs than the firm's managers. As a result, the venture capitalists may take the lead in deciding when and how a firm should go public. Empirical data supports the view that biotechnology venture capitalists, and seasoned venture capitalists in particular, are proficient at bringing their portfolio companies public near market peaks.[16-17] Bringing companies public when equity values are high minimizes the dilution of the venture capitalists' ownership stake.

If companies have better information about the present value or risk of their future cash flows than do investors, deliberate underpricing may be used to signal the company's 'true' high value. This is clearly costly, but if successful, signaling may allow the issuing firm to return to the market to sell equity on better terms in the future. Issuers deliberately underprice in order to 'leave a good taste in investors' mouths'. These public investors are then more willing to buy shares in follow-on offerings. In other words, "leaving something on the table for public market investors helps generate enthusiasm in new issues and their aftermarket trading".[6]

The rare disease drug developer Ultragenyx Pharmaceutical went public on Jan 31, 2014 at a price of $21 per share, with J.P. Morgan and Morgan Stanley as the lead underwriters. The stock traded up 101.2% in the first-day of trading. On July 9, 2014, the firm raised additional capital in a public offering at a price of $40 per share retaining J.P. Morgan and Morgan Stanley as lead underwriters. The $80.7 million offering (before underwriter fees) left the firm with $49.3 million in net proceeds and some of the selling stockholders (TPG Biotechnology Partners and A.M. Pappas Life Science Ventures) with $26.5 million. Note, however, that TPG and A.M. Pappas only sold a small fraction of their total shares, and several other preexisting investors, including Beacon Bioventures, HealthCap and hedge fund investor Adage Capital Partners did not sell any shares at all. It seems as if venture capitalists often appear generally content to leave so much money on the table. The same IPO underwriters in many instances lead-manage later seasoned equity offerings, as illustrated in the example above, indicating that venture investors at least are not left with a bad taste in their mouth of leaving considerable amounts of money on the table. Survey evidence in other industries suggests that switching lead underwriters for a follow-on offering is unlikely to be due to the amount of money left at the table, but rather by the desire to increase analyst coverage or underwriter prestige.[18]

Leaving money on the table may also help managing the exit of the portfolio firm (as long as there is a positive association between aftermarket performance and IPO underpricing). To explore this relationship, I use regression analysis. When running regressions, I came up with the following relationship:

$$\text{Aftermarket performance} = 6.80\% - 0.198 \times \text{First-day return}$$

The result is strongly statistically significant (p-value < 0.001). Figure 3 shows this relationship graphically. In sum, there is a strong negative correlation between aftermarket performance and first-day return. This may indicate that there is a "mean-reversion" in stock prices in the aftermarket – IPOs with large first-day returns tend, on average, to trade down in the aftermarket. However, in untabulated tests, there is a strong positive association between first-day return and the probability of the stock price to be above the IPO price over both the 12-, 24- and 48-month time period after the IPO. This suggests that leaving money on the table in IPOs may at least help to exit portfolio investments at valuations higher than the IPO price.

Several venture capitalists point out the challenge of dismantling their equity investments in the post lock-up period, especially when there are several venture capitalists that are running to the exit door at the same time putting a downward pressure on the share price. Oftentimes they have to wait to a key value inflection point, such as clinical trial results, which offers the liquidity to sell the shares on the open market.[2] The good news is that biotechnology venture capitalists very seldom sell shares in highly underpriced IPOs, which would be extremely painful. In fact, the trend in recent years, as pointed out by several practitioners, is the increasing role of insider participation by preexisting investors, including venture capitalists, and cross-over investors in the IPO. Insider participation, which is being examined in another study, was evident in some of the highly underpriced IPOs in Table 1 (e.g. Dicerna Pharmaceuticals had insider participation of 56.7%, Aduro Biotech (18.9%) and Seres Therapeutics (17.9%), and Spark Therapeutics (7.9%), whereas Juno Therapeutics, Ultragenyx Pharmaceutical and Foundation Medicine had no insider participation). Buying shares in highly underpriced IPOs has two effects: the loss (equity dilution) on preexisting shares by selling stock at a too low price is partly counterbalanced by the gain of purchasing underpriced shares.

CONCLUSIONS AND IMPLICATIONS

When companies go public, the shares that are sold tend to be underpriced, in that the share price jumps on the first day of trading. This study documents that the first-day return for U.S. venture-backed biotechnology companies averaged 17.5%, implying that venture capitalists left more than $6.3 billion of money on the table. This is nearly triple the amount paid in investment banker fees. Clearly, underpricing is costly to a firm's preexisting investors: the newly issued shares are sold at a too low price while the value of the shares retained after the IPO is diluted. The extent of underpricing tends to fluctuate a great deal over time. During hot IPO markets, such as the biotechnology bubble of 1999-2000, huge amounts of money was left on the table. More recently, during the current IPO window, the underpricing discount averaged 42.9 percent in Q3 2015. Notable, a high level of underpricing only translates into a large wealth

loss depending on the size of the offering. So it may be a small comfort for biotechnology venture capitalists that some tech venture investors are 'worse off'. In Twitter's IPO in 2013 more than $1.3 billion was left on the table, dwarfing Diversa's IPO in 2000 when $369.8 million was left on the table.

This study has presented different explanations to the underpricing phenomenon. Although information frictions, agency conflicts, grandstanding, prospect theory or 'leaving a good taste in investors' mouth' may explain why some issues are more underpriced than others, the huge variation in the degree of underpricing over time raises doubt whether these explanations can account for the massive amounts of money left on the table in hot IPO markets, such as the biotechnology bubble in 1999-2000, or more recently the current IPO window. Arising from this debate calls into question if behavioral explanations instead could help explain the huge variation in first-day returns. For example, a recent study[19] does not rule out that irrational investor behaviour may explain recent investment trends in biopharmaceutical R&D. Have surviving 'irrational' exuberant investors with overoptimistic beliefs about the future prospects for the current IPO companies from the genomic bubble finally returned to the market? Notable, eight of the thirteen VC-backed biotechnology IPOs with the largest amount of money left on the table in the history of biotechnology went public during 2014-2015. From an investor perspective, if the degree of underpricing in venture-backed biotechnology IPOs is an indicator of a pricing bubble, rational investors should at least be a little bit concerned about the state of the biotechnology equity market. In fact, a correction may already have occurred. The Nasdaq Biotechnology index (NBI) peaked at 4,166 on July 20, 2015, and is as of August 16, 2016, trading at 3,063 – a decline of 26 percent from the peak.

The venture capital industry has been subject to a great deal of uncertainty and controversy, following disappointing returns for many vintages during the first half of 2000s, where some academics and practitioners believe that the VC model is broken and need to shrink. Given the vast amounts of money left on the table, it is surprising that venture capitalists appear content to leave so much money on the table and put little pressure on underwriters to change the way IPOs are priced. Empirical evidence on other industries suggests that auction IPOs are associated with lower and less variable underpricing than are book-building IPOs.[20] But auctions (e.g. Google's IPO) have never been in favor for pricing biotechnology IPOs. From a management and venture capitalist perspective, issuing firms should at least consider the potential for using auctions to price and allocate IPOs to potentially decrease the amount of money left on the table in order to help improve venture capital returns.

SUPPLEMENTAL APPENDIX 1

The initial sample of venture-backed biotechnology firms was selected from the Thomson Financial's VentureXpert database using the MoneyTree classification "Biotechnology". These firms typically belong to one of the following primary Standard Industrial Code (SIC) identifiers: 283 (Drugs) and 8731 (Commercial Physical and Biological Research). The sample of firms was augmented with additional items and corrections using the Securities Data Company's (SDC) New Issues database and Jay Ritter's webpage (http://bear.warrington.ufl.edu/ritter/ipodata.htm) and the SEC website (http://www.sec.gov). As is common practice in financial research, equity carve-outs, unit offers, American Depository Receipts (ADRs) of companies already listed in their home countries, foreign firms (typically using F-1 filings) that went public in the U.S., small firms that choose to file for its IPO using the SB-2 program (instead of the traditional S-1 program), reverse leverage buyouts, and firms that previously traded on the OTCBB or the OTC QB were excluded. Stock price data was collected from CRSP and the Datastream database.

SUPPLEMENTAL APPENDIX 2

In this section, I examine in more detail the effect of underpricing and how this translates into wealth losses for preexisting shareholders. I will consider two cases. The first case (Genentech, Example 1 below), has only one component; that is, no secondary shares are sold and primary shares are issued in connection with the IPO. In the second case (Genoptix, Example 2) secondary shares are sold by preexisting investors and new primary shares are issued in connection with the IPO. We will see that a large degree of underpricing translates into a large wealth loss for preexisting shareholders when: 1) many new shares are issued relative to the number of shares outstanding prior to the offering, and 2) many secondary shares are sold. It is important to note that the first case is the by far most common for venture-backed biotechnology IPOs, whereas the second case (with secondary shares by preexisting investors in IPOs) is much more common for venture-backed firms in other sectors, such as information technology.

The original model was derived by Barry (1989)[21]. Let the (unobservable) value of an all-equity firm prior to going public be V_0. Prior to the IPO, there are S_0 shares outstanding held by preexisting ("old") shareholders,

such as venture capitalists. S_n new shares are sold in the offering at an initial offering price of P_0. Subsequent to the IPO, the market price of the shares at the end of the first day is P_1. If there is no information asymmetry after the IPO, then P_1 reflects the value of the firm prior to the offering, V_0, and the cash raised, $S_n \times P_0$, ignoring commissions and other direct costs of the offering:

$$P_1 = \frac{V_0 + S_n \times P_0}{S_0 + S_n} \quad (1)$$

Let P* denote the (unobservable) value of the shares prior to the IPO. Then $P^*=V_0/S_0$, and, substituting into equation (1), the full value of the shares P* can be found from the aftermarket price as

$$P^* = \frac{(S_0 + S_n)P_1 - S_n P_0}{S_0} \quad (2)$$

Equation (2) simplifies to a form which explicitly captures the dilution effect:

$$P^* = P_1 + \frac{S_n}{S_0}(P_1 - P_0) \quad (3)$$

If $P_1 > P_0$ (i.e. there is underpricing), equation (3) shows that the price at which shares could have been sold is larger than the aftermarket price, P_1. The difference, S_n/S_0 (P_1-P_0), represents the effects of dilution on the observed aftermarket price.

The gains to buyers of newly issued shares must be the wealth losses of the old shareholders (zero-sum game). From this wealth perspective, the correct percentage measure of underpricing from the issuer's point of view depends on the extent of participating by "old" shareholders in the offering by selling their own shares.

Example 1: Genentech's IPO

On October 14, 1980, Genentech made its initial public offering. The offering price was $35 per share, and the close of the first day of trading was $71.25. Excluding the overallotment option, 1 million shares were sold (no secondary shares were sold as part of the IPO), and there had been 6,472,102 shares outstanding prior to the IPO. In terms of notation in the previous section, the issue had these values:

$P_0 = 35$
$P_1 = 71.25$
$S_0 = 6,472,102$
$S_n = 1,000,000$
$S_{0,s} = 0$ (no insider selling)
$S_{0,R} = 6,472,102$ (retained shares)

The unobservable share value P* is (from equation 3)

$$P^* = 71.25 + \frac{1,000,000}{6,472,102} \times (71.25 - 35) = 76.85$$

New shareholders received a wealth transfer of 1,000,000 × ($71.25-$35) = $36.25 million, which is the amount of money left on the table. Shares retained by preexisting shareholders were diluted by the offering to a value of $71.25 from a pre-offering inferred value of $76.85: they lost $5.60 per old share ($76.85-$71.25). In dollar amount, this is equivalent to the money left on the table, i.e. $36.25 million (6,472,102×$5.60). The loss per retained share was 5.60/76.85 = 7.29%.

Example 2: Genoptix IPO

On October 29, 2007, Genoptix went public. The offering price was $17 per share, and the close of the first day of trading was $25.35, which translates into a 49.1% first-day return. Excluding the overallotment option, 5,000,000 shares were sold (714,286 were secondary shares), and there had been 11,333,576 shares outstanding prior to the IPO. The venture syndicate of six investors, led by Enterprise Partners, each owning more than five percent of the shares prior to the offering, sold a total of 695,988 shares (97.4% of the secondary shares sold). In terms of notation in the previous section, the issue had these values:

$P_0 = 17$
$P_1 = 25.35$
$S_0 = 11,333,576$
$S_n = 5,000,000$
$S_{0,S} = 714,286$ (insider selling)
$S_{0,R} = 10,619,290$ (retained shares)

The unobservable share value P* is (from equation 3)

$$P^* = 25.35 + \frac{5,000,000}{11,333,576} \times (25.35 - 17) = 29.03$$

New shareholders received a wealth transfer of 5,714,286 × ($25.35-$17) = $47.71 million, which came out of the pockets from the preissue shareholders. Shares retained by preexisting shareholders were diluted by the offering to a value of $25.35 from a pre-offering inferred value of $29.03: they lost $3.68 per share (or $3.68 × 10,619,290 = $39.12 million). Old shareholders who sold 714,286 of their shares in the offering gave up 29.03-17=12.03 (or $12.03 × 714,286 = $8.60 million), i.e. 12.03/29.03 = 41.45%. For the 10,619,290 shares retained by old shareholders, however, the loss was only 3.68/29.03=12.69%. This number is much smaller than

the initial return (which was 49.1%) and much smaller than the 41.45% lost by old shareholders who sold their shares.

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