IPO Lockup Expirations: A Persistent Anomaly of Scale

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Abstract

This paper analyzes stock returns around IPO lockup expirations over a 27 year period from 1988 to 2014 and finds venture capital backed IPOs generate an average 3-day cumulative abnormal return of negative 2.75 percent. Abnormal returns are highly persistent despite a decline in trading costs and an increase in IPO lockup publicity. After controlling for liquidity and portfolio constraints I find excess returns endure but are limited in scale. The results suggest the abnormal return pattern is sensitive to the size of capital investment.

IPO lockup agreements prohibit company insiders from selling stock for a specified time period, typically 180 days, following an IPO. Once the lockup agreement expires, insiders are free to sell shares to the public subject to insider trading regulations. Conventional wisdom suggests the downside price pressure generated by insider selling activity leads to negative stock returns on the expiration date.

Documenting this phenomenon, Field and Hanka (2001) use a sample of IPOs between 1988-1997 and find a cumulative abnormal return (CAR) equal to -1.5% in the three day window around the lockup expiration date (studies by Bradley et al. (2001) and Ofek and Richardson (2000) offer similar findings). While the abnormal return findings confirm popular beliefs, it is curious why the return dynamics exist. In other words, why do rational investors fail to adjust the IPO stock price prior to a lockup expiration? In this paper I examine whether negative returns around IPO lockup expirations persist in an updated sample, and evaluate whither the market behaves irrationally or if trading frictions and excess downside risks impede investor participation.

Absent confounding events, a decline in stock prices following IPO lockup expirations can be explained two ways: 1) insider stock sales may convey negative information regarding future performance, thereby reducing the expected value of the firm, or 2) if insiders sales are merely mechanical rather than informative, then an increase in the supply of shares coupled with a decline in the stock price supports a model where demand for stocks is downward sloping.[1] Regardless of whether the decline in stock prices is due to unexpected insider trading or a downward sloping demand curve, a persistent negative abnormal return should not exist in an efficient market. Market participants should not consistently underestimate insider trading activity, nor should they impulsively pay a premium for stocks prior to a lockup expiration.

The stock performance of the social networking company Twitter, following the firm's lockup expiration, exemplifies the markets' apparent willful ignorance. On May 6, 2014, 470

[1]Field and Hanka (2001) find evidence to suggest both factors may play a role in stock price declines

million shares of Twitter stock, representing 82% of all shares outstanding, became eligible for sale when the company's lockup agreement expired. Details of the lockup agreement were included in public filings prior to the expiration, yet in a seemingly knee-jerk reaction the stock price declined 18% on ten times the average daily trading volume on the lockup expiration date. Explanations to such anomalies typically fall into three categories: (1) the market is inefficient; (2) trading costs or other constraints limit investor participation; and (3) the returns compensate for risk. Field and Hanka (2001), in an appeal to categories (1) and (2), report news coverage on lockup expirations is extremely limited (less then 1% of IPOs and almost always post expiration), and find trading costs, in the form of bid-ask spreads, eliminate short term trading profits.

Current market conditions suggest these barriers are less restrictive. Bid-ask spreads on the NYSE and NASDAQ, the dominant trading venues for IPOs, fell substantially following the conversion to a decimal pricing system in 2001 (Bessembinder (2003)). The effect is similar for IPO stocks, such that bid-ask spreads are dramatically smaller than the pre-decimalization period studied previously. I find bid-ask spreads as a percentage of share price declined from approximately 3.4% to 0.5% in the post-decimilazation sample period. Despite lower trading costs, I show the abnormal return pattern persists at a similar magnitude to previous findings. In addition, numerous websites and news service providers now offer tracking tools to monitor lockup expirations, thereby reducing the likelihood investors are uninformed. Incognizance and trading expense may have enabled past abnormal returns, but it is difficult to argue the same forces remain relevant.

Given the historical consistency and publicized nature of negative returns around IPO lockup expirations, it is reasonable to expect informed traders may attempt to profit from this dynamic. A knowledgeable investor could short sell shares of the IPO firm immediately prior to a lockup expiration and buy back the shares post expiration at a lower price. The absence of short sellers would suggest either market participants are uninformed, or trading constraints in the form of limited lending supply and/or high security lending borrow costs

prevent short term profits. To discover whether such activities are present in the market, I analyze short sell trading volume in a subsample of years from 2012-2014 for which daily short sell trading data is available.

I find abnormally high (low) levels of shorting activity immediately before (after) the lockup expiration date. This evidence supports conclusions that 1) some market participants are informed and 2) a short sell strategy is not cost prohibitive. Short interest, the aggregate number of shares sold short, is also analyzed in the reporting period immediately before and after the lockup expiration. The data shows short interest increases by less than 1% on average post expiration, indicating the spike in short sell activity is generated by short-term trading strategies rather than negative long-term sentiments.

An interesting result generated by the short sell analysis appears to suggest informed traders in this market more closely resemble technical traders acting on historical trends rather than market participants with superior information. The increase in short sell activity prior to the lockup expiration is most prominent in venture capital backed IPOs, which mirrors the abnormal return profile. However within the subsample of venture capital backed IPOs, the jump in short sell activity is consistent regardless of the post lockup expiration stock performance. It appears as though the informed trader participates with knowledge that on average the strategy winners outnumber the losers, but cannot accurately predict the individual outcomes ex ante. This result suggests informed traders who short sell stocks may face considerable risk from stock prices potentially increasing, rather than decreasing, after the lockup expiration.

To account for the risks borne by market participants, I generate a trading algorithm with investment allocation controls for both portfolio composition and trade volume restrictions. The trading strategy mimics the abnormal return pattern found in the data such that securities are sold short one day prior to the lockup expiration and repurchased the day following expiration. Additions to the portfolio are restricted by the average daily trading volume prior to the investment date and a single IPO may not exceed 10% of the total

portfolio. These limitations attempt to incorporate the realistic trading restrictions faced by portfolio managers. I find investment returns are positive across all levels of capital and trading volume restrictions. Furthermore, returns are highly consistent, and fail to exhibit appreciable down side risks in the form of unrecoverable losses over a given time period. I also test the portfolio returns using the Fama-French-Carhart four factor model (Fama and French (1993), Carhart (1997)), and find significant abnormal returns persist, but are sensitive to the amount of capital deployed. For a $1 million and $10 million portfolio, the 4-factor alpha ranges from 2.7-6.2% and 0.7-2.7% per annum, respectively, depending on the trading volume constraint.

These results suggest market inefficiencies may play a role in stock returns around IPO lockup expirations. Market anomalies are often described as picking up pennies in front of a steamroller, where attempts to profit can prove disastrous. For large institutional investors, the capital limitations make the IPO lockup expiration investment strategy akin to picking up pennies. However, here returns are highly consistent, and not characterized by the type short term trading loses where participants get "steamrolled". Interestingly, it appears investors may simply ignore the pennies in search of larger denominations. In other words, the investment scale constraints alone may the drive the anomaly absent excessive downside risk.

The remainder of this paper is organized as follows. Section 1 provides a brief overview of IPO lockups and a description of the data used in this paper. Section 2 describes the abnormal return calculations and provides summary statistics of the sample data. Section 3 presents test results on the updated sample in regard to trading costs, informed trading and portfolio constraints. Section 4 concludes.

1 Data Description

1.1 Background on IPO lockups

An IPO lockup agreement is an agreement between the IPO underwriter and company insiders, including employees, board members and majority stakeholders, and restricts insiders from selling shares for a specific time period, typically 180 days, following the initial offering. The lockup agreement serves two objectives: (1) it allows underwriters, tasked with fulfilling their commitment obligation, to source demand for shares as the sole supplier absent competition from liquidating insiders; and (2) it can alleviate agency costs by tying manager wealth to firm performance (Brav and Gompers (2003)). The agreement terms and number of restricted shares are detailed in the IPO firm's prospectus filed with the SEC in conjunction with the offering. On average over sixty percent of the initial shares outstanding are subject to lockup provisions. After the lockup expires, insiders are free to sell shares subject to insider trading laws.[2]

1.2 Data

I extract all IPOs included in the SDC database from 1988 to 2014. The IPO data is merged with the CRSP daily stock file to obtain daily stock returns and trading volume for the period before and after the lockup expiration. Consistent with earlier research, IPOs with the following characteristics are excluded: penny stocks (stocks with offering prices below $5); mutual-to-stock conversions; non-common stock offerings (unit offers, REITs and ADRs); and carveouts (additional exclusions for confounding events (i.e. earnings announcements) and seasoned offerings prior to lockup expiration have not been made). Earnings announcement dates, insider trading filings and Schedule 13F filings data are all sourced from Thompson Reuters.

[2]Rule 144 limits the amount of shares sold by an insider to the maximum of 1% of the total shares outstanding or the average weekly trading volume over the prior four week interval.

The daily short sell trading volume used in this study includes the daily short sale trading activity in the U.S. from 2012 to 2014. This data includes the total short volume by security as reported by all public exchanges in the U.S. as well as private trading venues reported by FINRA. Short interest data is sourced from Compustat. I also make use of stock option data from Option Metrics.

1.3 Summary Stats

Table 1 below shows the sample summary statistics by the IPO year. There are a total of 3,647 IPOs included in the sample. IPO activity is positively correlated to the overall market performance as evidenced by the strong IPO market from 1992 to 2000 followed by three years of more tepid activity as investors grappled with the dotcom collapse. The financial crisis in 2007 also resulted in a follow-on period of weaker activity in 2008 and 2009. Overall the distribution of IPOs across the sample years is fairly robust.

The typical lockup period lasts 180 days with little variation outside of the early sample years. On average, firms sell approximately 35% of the total shares outstanding to the public, with almost all of the remaining shares held by insiders and subject to lockup provisions.[3]

The relatively small percentage of shares sold to the public highlights the potential for a dramatic increase in the supply of shares when the lockup expires. Venture capitalists (VCs) back 44% of the IPOs in the sample and are the main focus of this study. The totals summary at the bottom of Table 1 shows VC backed IPOs are characterized by a higher percentage of shares subject to lockup provisions while the lockup duration is similar for both subsets. All else equal, the higher lockup percentage equates to greater risk of oversupply post expiration.

The oversupply risk is exemplified by Figure 1 below, which shows the average trading

[3]It is worth noting there is often a small percentage of shares (<5%) held by insiders that are not subject to lockup agreements. The SDC data is incomplete for the number of shares subject to lockup agreements, however, in a comparison to a hand collected dataset, Field and Hanka (2001) find the percentage of shares offered to be highly accurate and use the remaining portion of shares as a proxy for the percentage subject to lockup agreements. I follow this same methodology in later tests.

volume over the event window trading days starting from t=-120 to t=120, where t=0 represents the lockup expiration day. The plot shows volume levels gradually rise as the lockup expiration approaches (note the abnormal spike in volume around t=-60 is due to IPOs with 90-day lockup periods), followed by a significant increase post expiration. The increase is not temporary, but rather appears to be permanent, which is consistent with earlier literature. To better extrapolate the trading volume activity post lockup to the pre-lockup expiration levels, I use the following abnormal volume measure

$$ABV(1,T) = \left[\frac{\frac{1}{T}\sum_{t=1}^{T} V_{i,t}}{\frac{1}{60}\sum_{t=-60}^{t=0} V_{i,t}} \right] - 1 \tag{1}$$

where T is the number of trading days from the IPO lockup expiration date, and $V_{i,t}$ is the trading volume activity for firm i on day t. Table 2 below shows the abnormal trading volume for the 1, 3, 5, 10, 20 and 60 day trading windows post lockup expiration. Trading activity the day following the lockup expiration is on average approximately double the volume levels pre-lockup expiration. Although trading volumes decline as the window expands from the lockup expiration date, the average post lockup expiration daily trading volume exhibits an increase of approximately 50% above the pre-lockup expiration levels. This result is consistent with the notion that an increase in supply of shares is generated by liquidating insiders.

2 Analysis

2.1 Abnormal Returns

To evaluate stock performance around the IPO lockup expiration I follow the abnormal return calculation methodology utilized by Field and Hanka (2001). The cumulative abnormal return, or CAR, for firm i is defined as:

$$CAR_i = \left[\prod_{t=-1}^{+1} \left(\frac{1 + R_{i,t}}{1 + R_{m,t}} \right) - 1 \right] \tag{2}$$

where $R_{i,t}$ is the daily return on day t for firm i and $R_{m,t}$ is the daily CRSP value-weighted index return on day t. Table 3 below shows the abnormal return summary for the following three time periods: 1) 1988-1997 (the time period that matches Field and Hanka (2001)), 2) 1998-2014 (the updated portion of the sample), and 3) 1988-2014 (the full sample period).

The CAR measures for the time period 1988-1997 closely resemble the findings in Field and Hanka (2001). Specifically the the 3-day CAR (days $t = -1$ to $t = 1$) in this report equates to -1.43% compared to the -1.5% 3-day CAR reported previously. The updated sample period also produces a significant negative 3-day CAR, but at a slightly lower level of -1.26%. Differences also exist in the timing of stock price declines between the two sample periods. Interestingly, the negative abnormal returns appear earlier in the pre-lockup expiration window of the updated sample, where the daily abnormal return for days $t = -5$ to $t = -1$ are all negative and 4 out of 5 are statistically significant. Therefore the 7-day CAR (days $t = -1$ to $t = 5$) in the updated sample period is actually larger (more negative) at -2.07% compared to -1.66%. The pre-event window stock decline suggests informed trading may occur ahead of the lockup expiration. Despite the potential presence of informed trading, negative abnormal returns remain.

Figure 2 plots the cumulative negative abnormal return for the trading days $t = -50$ to $t = +50$ around the lockup expiration window. The returns are plotted for the overall sample as well as VC and non-VC backed subgroups. The plot illustrates that negative abnormal returns are driven primarily by VC backed firms, which is consistent with previous findings. In the overall sample, non-VC backed IPOs decline modestly, less than 1%, leading up to the lockup expiration, followed by a slight rebound in the 5-day window post lockup expiration. In a sharp contrast, VC backed IPOs decline substantially in the period immediately prior to the lockup expiration, thus illustrating further evidence of informed trading. The decline VC-backed firms continues post expiration, but at a more moderate pace.

2.2 Bid-Ask Spreads

Field and Hanka find bid-ask spreads prohibit short term profits, or risky arbitrage. Informed traders potentially aware of an impending drop in the stock price were unable to take advantage because the trading costs exceeded the expected profit. Starting in 2001, the NYSE and NASDAQ implemented a decimal pricing system that reduced bid-ask spreads substantially in both markets (Bessembinder (2003)). Table 4 shows the break down of abnormal returns by year for the subsamples of IPOs backed by venture capitalists and non-VC backed IPOs. Non-VC backed IPO abnormal returns are not statistically significant for any individual year or in the overall sample. Conversely, VC-backed IPOs generate significant negative abnormal returns in almost every year, with only a handful of small sample years failing to meet the threshold.

The bid-ask figure presented in Table 4 is calculated by dividing the bid-ask spread by the closing stock price. This percentage estimates the effective trading cost of shorting a stock at the bid price and buying it back at the ask price. On average the trading costs are higher than the potential returns gained by informed traders in pre-decimilization years (1988-2001). However the post-decimalization time period, starting in 2002, shows the average bid-ask spread fell dramatically. The average bid-ask spreads over the last 12 years of the sample period is slightly above 0.5%. Contrary to the results in Field and Hanka (2001), bid-ask spreads do not appear to represent a barrier to short term profits in the updated sample. In fact the average 3-day CAR for VC backed IPOs from 2002-2014 is -2.14%, far greater than the trading costs associated with the bid-ask spread. Despite the reduction in trading costs, the negative abnormal returns remain relatively unchanged from earlier time periods.

2.3 Shorting Activity

Profiting on stock price declines following IPO lockup expirations may be inhibited by short sell constraints. Short sell constraints become a factor when the stock lending supply is limited, which results in the inability to borrow shares or excessive borrow costs. If informed

traders are excluded from shorting shares ahead of lockup expirations, then stock prices could be overvalued (Miller (1977)). Geczy, Musto, Reed (2002) find stock price declines around IPO lockup expirations are robust even for firms with cheap and easy to borrow stocks, but it is possible current conditions may be different. I use short sell trading activity as a proxy for shorting restrictions, and focus on the abnormal shorting activity immediately prior to lockup expirations. The short sell volume data covers the years 2012-2014, and includes a total of 260 IPO lockup expirations that occurred over this time period. Abnormal shorting activity is modeled after Christophe, Ferri and Angel (2004). The authors compare the average short selling activity for the x-day period preceding the event date to the average short sale activity outside of the event window. The abnormal shorting activity is calculated as:

$$ABV(t-x,t) = \left(\frac{AvgVol(t-x,t)}{AvgVol(t-(x+60),t-(x+1))} \right) - 1 \tag{3}$$

where t is the number of trading days from the IPO lockup expiration date, $AvgVol(t-x,t)$ is the average shorting activity over the prior x-day period, and $AvgVol(t-(x+60),t-(x+1))$ is the average short selling volume for 60-day period ending prior to the target trading window. Here x is set equal to 1 to highlight the change in trading activity immediately before and after the lockup expiration. Table 5 below shows the abnormal trading activity as measured by short sale volume, short sale volume as a percentage of total volume, and total volume around the lockup expiration date. The days column indicates the number of trading days from the expiration date. The "Mean" columns display the average trading activity for the respective trading day, and the "Abnorm" columns show the abnormal trading activity measure. Positive (negative) Abnorm figures represent above (below) average trading activity. Panels A and B break the sample into non-VC and VC backed IPOs, respectively.

Table 5 shows short sale volume for both VC and non-VC backed IPOs increases in the days leading up to the expiration, peaks the day after the lockup expires, and then declines in the remaining days of the 10-day event window. This result suggests short sellers primarily

enter the market post expiration, however conclusions based on raw short sell volume can be misleading. Market makers generally short sale stocks as a byproduct of their intermediary role. Therefore as more shares exchange hands, short sale volume will likely experience a similar rise. Indeed the abnormal short volume and total volume patterns closely mirror each other in both subsamples. The difference in trends is captured by the short sale volume as a percentage of total volume, or SVP. This metric highlights shorting activity relative to overall trading.

SVP increases in both subsamples before the lockup expiration, followed by a decline starting on the expiration date. Compared to the 60-day averages, SVP is abnormally high (low) in the period before (after) the event date. The mean SVP level is also informative, and provides a key distinction between the two subgroups. The equal weighted average daily SVP across all stocks included in CRSP over the period from 2012-2014 is 41%. The Non-VC backed SVP peaks to just over the average at 42%, however, the average VC backed SVP reaches 52% the day before the lockup expires, which is about 25% higher than the average firm.

The scatter plots in Figure 3 visually illustrate short sale activity around the lockup expiration date. The plots are generated by taking an average level of trading activity across all IPOs in the sample (broken into sub-groups for VC and non-VC IPOs) on each day. The plots for short volume and total volume depict a similar story, both highlight high levels of initial activity followed by sharp decline over the first 30-days of market trading. Approximately 90 days prior to the lockup expiration, volume levels begin to increase and peak over the 10 day window around the expiration date. Interpreting the relative level of shorting activity from the short and total volume plots is arduous. However, the SVP plot provides a striking depiction of the increase in shorting activity over the lockup period that peaks on the days prior to the lockup expiration, and then falls dramatically on the expiration day. When comparing VC and non-VC backed IPOs we see a similar pattern of short sale activity, but a far more significant effect in VC backed IPOs. This is again

consistent with the story informed traders are aware of this phenomenon and trade ahead of lockup expirations. The short sellers preference for VC backed IPOs suggests informed traders are knowledgeable of the fact that VC backed IPOs serve as the primary driver behind the abnormal returns.

Constraints on short sells should be reflected in the level of shorting activity. Here I find that VC backed IPOs experience an increase in both the absolute and relative short sell measures prior to the lockup expiration. This pattern does not suggest short sellers are constrained prior to the expiration date, but rather appears to reflect informed trading activity.

It is curious whether short sell activity can predict the cross-section of returns within VC backed firms. Studies by Boehmer, Jones and Zhang (2008), Asquith, Pathak and Ritter (2005), and Desai, Ramesh, Thiagarajan and Balachandran (2002) all find empirical evidence to conclude more heavily shorted stocks under perform lightly shorted stocks. In unreported results, I find short sell activity is uncorrelated with stock returns around the lockup expiration within the subsample of VC backed IPOs. Figure 4 illustrates why. Here we see short sell trading activity for VC backed IPOs with negative and positive CARs around lockup expiration are virtually identical. In both sets of plots short volume as a percentage of total volume increases to approximately 50% immediately prior to the lockup expiration, and declines approximately 10% in the days following expiration. Table 6 groups stocks into quintiles based on short volume, short volume percentage and total volume to highlight the respective 3-day CAR within each subgroup. The results shows stocks with the highest short sale volume, and consequently the highest total volume, generally under perform the least shorted group. However the difference between the two groups, identified as the HML, or high-minus-low group, is not statistically significant. The SVP groups in Panel B produce an even lower variation between the highest and lowest quintiles. These results highlight that while short sellers may be able to distinguish between VC and non-VC backed firms, they cannot accurately identify which VC backed IPOs will decline in price

post expiration. Hence, the level of informativeness is restricted, and suggests the informed traders are transacting primarily on pattern recognition rather than private information.

2.4 Illiquid Stocks

It is possible negative abnormal returns are concentrated in illiquid, or thinly traded stocks where trading might prove difficult. Table 7 presents the subsample of VC backed IPO stocks grouped into quintiles based on the average daily total volume over a range of time horizons. To account for potential time variation in trading volume levels, the quintile groups are defined by the year in which the lockup expiration occurs. The results show the negative abnormal return among VC backed IPOs is present, and statistically significant, across all quintile groups. Although the lowest volume group (Group 1) generates a stronger negative CAR on average, the difference between the highest and lowest group, Group HML, is not statistically significant in any of the average trading volume measures.

2.5 Options

Informed investors may also generate short term profits around IPO lockup expirations by trading in the options market. Applicable strategies include simply buying put options, or using multiple long and short option positions to create a synthetic short, bear spread or similar strategy. Table 8 provides the summary statistics on the subsample of IPO firms with traded options for the sample years 1996-2014, the dates for which option data is available from Option Metrics. I consider only firms with trading volume in put options the day prior to the lockup expiration. Only 9% of the sample exhibit a liquid options market, but that figure increases to approximately 26% in the last 4 years of the sample period. In terms of the proportion of IPOs backed by VCs, the percentage of shares sold and the average lockup period, IPOs with options traded are similar to the overall sample.

Easley, OHara, and Srinivas (1998), argue option trading volume can provide information on future stock movements, thereby making stock prices more accurate in the presence of

informed trading. It is possible prices for IPO stocks with a liquid options market may be more informative, and fail to exhibit the negative 3-day CAR around the lockup period. Table 9 shows that firms with traded options in this sample actually generate a higher negative CAR on average compared to the overall group of VC backed IPO firms. Of the 108 VC backed IPOs with traded options from 1996-2014, the average CAR was -3.47%, or 37 basis points higher (more negative) than the overall sample during the same time period. Thus the availability of options does not appear to impact the negative return dynamics around the lockup expiration in VC backed IPOs.

2.6 Portfolio Trading Strategy

Market anomalies are sometimes the byproduct of trading costs (Lesmond el al. (2004), Korajczyk and Sadka (2004), Mitchell and Pulvino (2001)). In addition, the risks faced by would be short term profit takers can limit the amount of capital invested in so called risky arbitrage (Shleifer and Vishny (1997)). To test whether the abnormal returns are robust to trading costs and portfolio considerations, I generate a simple portfolio trading algorithm. The trading strategy entails short selling VC backed IPOs stock the day prior to the lockup expiration and repurchasing the shares the day following expiration. Short sells are executed at the prior day closing bid price, and repurchases are transacted at the closing ask price on the day the position is unwound. Indirect trading costs are captured through trade volume based position size limits of 1%, 5%, and 10% of the average daily trading volume. For liquid stocks with high levels of trading activity, portfolio positions are limited to 1/10th of the current portfolio value. Portfolio cash not allocated to stock positions is assumed to earn the one-month treasury bill rate.

Large bid-ask spreads generate portfolio losses in early sample years, therefore I initiate the trading strategy in the year 2002, the first full calendar year post decimalization. Table 10 shows the results for four initial starting capital levels and three trading volume restrictions. Returns increase as volume restrictions are eased, and decrease as starting capital levels rise.

Hence the investment strategy is limited in scale. Performance is also capped by the level of IPO activity. In 2003 and 2009, for example, weak IPO markets encumber investment activity beyond interest earned on cash. In all cases the Sharpe ratio levels exceed the market, indicating the strategy performs well on a risk adjusted basis despite lower level returns at higher capital levels.

I use the Fama-French-Carhart four factor model (Fama and French (1993), Carhart (1997)) shown in Equation 4 below to test the risk factor loadings on the portfolio returns. Ret_t is the daily portfolio return, R_f is the risk free rate, α is the regression intercept, or abnormal return, R_{mkt} is the crsp value weighted average index return, and R_{hml}, R_{smb}, and R_{umb} are the high book-to-market minus low book-to-market portfolio returns, small minus big, and momentum returns series.

$$Ret_t - R_f = \alpha + \beta_{mkt} * (R_{mkt} - R_f) + \beta_{hml} R_{hml} + \beta_{smb} R_{smb} + \beta_{umb} R_{umb} \tag{4}$$

I regress the daily portfolio returns on the common risk factors and find the model fails to accurately predict returns. The regression coefficient estimates and R-squared values are shown in Table 11. Virtually all of the factor coefficients are estimated near zero, which suggest the strategy returns are not impacted by market conditions. The positive and statistically significant excess returns, or alpha values, indicate abnormal returns persist even after trading costs and portfolio concentration limits are considered. The reduction in excess returns are higher levels of capital may dampen informed traders' desire to enter the market. This is inconsistent with an efficient market hypothesis, as rational investor should be attracted to the abnormal returns despite limits on capital investment. An argument can be made that entry costs preclude participation, but this objection is weak as the strategy employed herein is not sophisticated and requires minimal monitoring.

3 Conclusion

IPO lockup expirations have been shown to generate negative abnormal returns in the trading window immediately surrounding the expiration date. The return pattern conflicts with basic efficient market hypotheses, which suggests the IPO shares should be priced with the expectation of future stock price declines. Field and Hanka (2001) highlight that arbitrage is limited due to large trading costs in the form of bid-ask spreads and a potential uninformed market. Despite wide press coverage on IPO lockup expiration and a significant decline in bid-ask spreads post decimalization, I find the negative 3-day cumulative abnormal returns around VC-backed IPO lockup expirations persist at similar levels of 2.75%.

I find short sell volume offers strong evidence of informed trading prior to lockup expirations, but little evidence of shorting restrictions. Short sell activity spikes immediately prior to lockup expirations and then falls below average pre-expiration levels, a pattern consistent with informed trading. Average short sell volume peaks at just over 50% of total trading volume on the two days prior to expiration, which exceeds the average levels for all stock over the same time period. Interestingly, short sellers do not appear to be able to accurately predict which VC-backed IPOs will decline post lockup expiration.

Finally, I test the prevailing abnormal returns against a portfolio trading strategy that limits the size of positions based on portfolio composition and trading volume. I find IPO lockup abnormal returns are robust to trading costs, but at low capital levels. A significant capital allocation reduces excess returns.

The combined results highlight a market anomaly that should not exist under a strict definition of efficient markets. However limits on the level of capital deployed, or the investment strategy scalability, may explain why the return pattern persists without capturing the attention of market participants.

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Table 1

Summary Statistics

This table shows the average annual statistics for the 3,647 IPOs with lockup agreements included in the sample from the period 1988 to 2014. VC% is the percentage of firms in each time period identified by SDC as backed by venture capital investors. % Shrs Sold is the percentage of shares outstanding sold in the IPO as identified by SDC. The mean lockup period shows the average duration of the lockup period measured in days. The last three columns show the percentage of firms with lockups less than, equal to, and greater than 180 days.

Issue Year	Obs	VC %	% Shrs Sold	Mean Lockup	<180 Days	180 Days	>180 Days
1988	30	0.60	32	172	0.43	0.43	0.13
1989	46	0.50	31	185	0.37	0.54	0.09
1990	53	0.43	40	190	0.40	0.45	0.15
1991	156	0.50	33	193	0.19	0.69	0.12
1992	211	0.44	38	212	0.08	0.76	0.16
1993	266	0.45	37	193	0.09	0.79	0.12
1994	222	0.38	36	208	0.05	0.80	0.15
1995	262	0.51	33	201	0.03	0.85	0.11
1996	251	0.47	30	206	0.03	0.86	0.11
1997	218	0.39	37	202	0.05	0.82	0.13
1998	111	0.26	34	187	0.09	0.84	0.07
1999	181	0.64	26	181	0.09	0.87	0.04
2000	119	0.76	22	181	0.04	0.92	0.03
2001	20	0.85	27	180	0.10	0.85	0.05
2002	64	0.22	31	182	0.02	0.97	0.02
2003	83	0.29	48	181	0.07	0.89	0.04
2004	226	0.34	47	183	0.10	0.82	0.08
2005	195	0.24	46	184	0.14	0.76	0.10
2006	153	0.39	34	191	0.08	0.78	0.13
2007	183	0.42	36	185	0.03	0.93	0.04
2008	20	0.35	33	180	0.00	1.00	0.00
2009	50	0.22	39	175	0.06	0.94	0.00
2010	100	0.41	35	184	0.05	0.91	0.04
2011	91	0.42	32	182	0.03	0.95	0.02
2012	104	0.43	31	179	0.05	0.90	0.05
2013	141	0.50	31	179	0.03	0.96	0.01
2014	91	0.65	27	179	0.02	0.97	0.01
Non-VC	2051	0.00	40	199	0.07	0.81	0.12
VC	1596	1.00	29	181	0.09	0.87	0.05
Total	3647	0.44	35	191	0.08	0.83	0.09

Figure 1

Average Daily Trading Volume

This chart shows the average daily trading volume around the IPO lockup expiration date. Included are average trading volumes from t=-120 to t=120, where t=0 on the lockup expiration day.

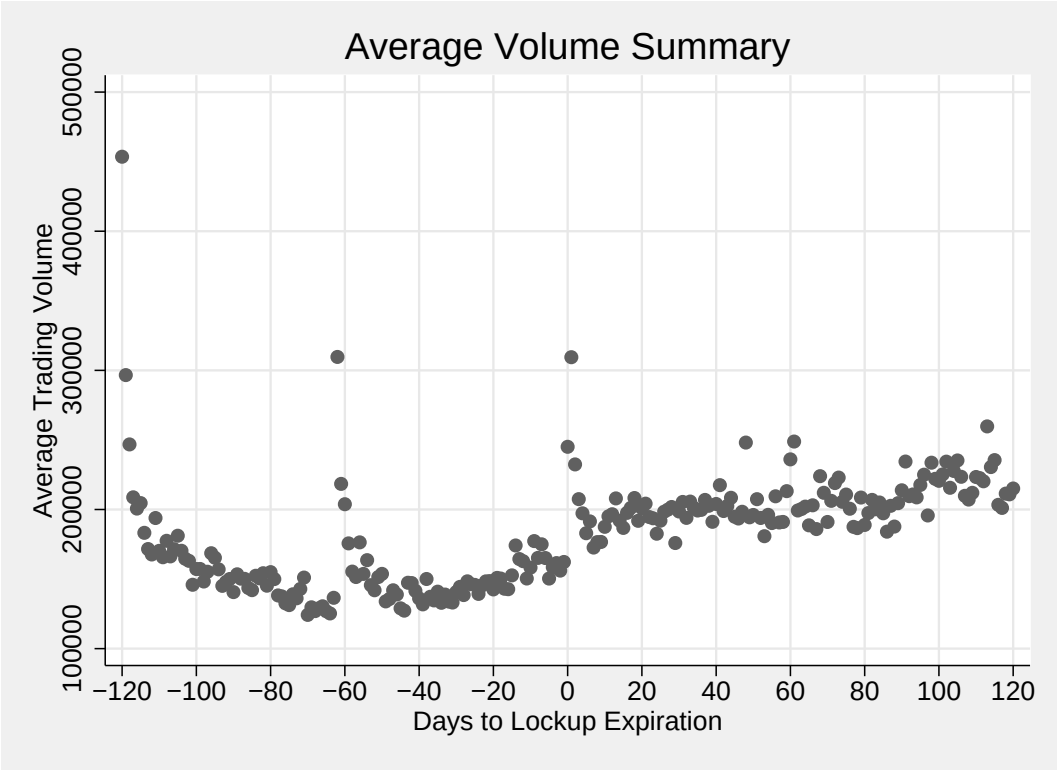


Table 2

Abnormal Volume Around Lockup Expiration

This table shows the average annual abnormal volume statistics for the 3,647 IPOs with lockup agreements included in the sample from the period 1988 to 2014.****CONFIRM WHY IS THE NUMBER SAMPLE NUMBER DIFFERENT THAN TABLE 1***. Abnormal volume levels are measured for the 1, 3, 5,10, 20 and 60 days trading windows post-lockup expiration. The average post expiration volume levels are compared to the pre-lockup expiration 60 day average trading volume using the following formula where $T =$ is the number of trading days post-lockup expiration.

$$ABV(1,T) = \frac{\frac{1}{T}\Sigma_{t=1}^{T} V_{i,t}}{\frac{1}{60}\Sigma_{t=-60}^{t=0} V_{i,t}}$$

	1-Day		3-Day		5-Day		10-Day		20-Day		60-Day	
Year	**obs**	**AVG**	**obs**	**AVG**	**obs**	**AVG**	**obs**	**AVG**	**obs**	**AVG**	**obs**	**AVG**
1988	15	1.94	15	0.41	15	0.15	15	0.05	15	0.20	15	0.18
1989	27	0.22	27	0.34	27	0.36	26	0.53	25	0.49	24	0.42
1990	68	−0.07	68	0.37	68	0.30	68	0.17	68	0.17	67	0.36
1991	82	1.02	82	0.71	82	0.55	82	0.55	82	0.57	82	0.69
1992	210	1.25	210	0.81	210	0.59	210	0.45	210	0.39	209	0.33
1993	204	0.44	204	0.27	204	0.22	204	0.18	204	0.17	204	0.15
1994	287	0.45	287	0.46	287	0.50	285	0.33	283	0.27	272	0.22
1995	179	1.29	179	0.77	179	0.50	179	0.34	179	0.33	178	0.44
1996	325	1.13	325	0.66	325	0.50	325	0.43	324	0.48	323	0.46
1997	198	0.86	198	0.40	198	0.34	198	0.31	198	0.29	197	0.48
1998	214	0.76	214	0.48	214	0.39	213	0.33	212	0.31	208	0.29
1999	115	0.26	115	0.13	115	0.17	115	0.36	114	0.28	110	0.60
2000	179	0.83	178	0.68	178	0.52	177	0.38	176	0.27	172	0.20
2001	73	1.50	73	1.61	73	1.32	73	1.07	73	0.75	73	0.67
2002	57	1.93	57	1.18	57	0.95	57	0.58	57	0.48	56	0.39
2003	48	0.56	48	0.44	48	0.33	48	0.30	48	0.45	48	0.55
2004	173	1.95	173	1.07	173	0.74	173	0.58	172	0.59	171	0.89
2005	222	1.32	221	0.62	221	0.52	221	0.40	221	0.33	220	0.50
2006	167	0.65	167	0.49	167	0.43	167	0.30	167	0.36	165	0.84
2007	193	0.54	193	0.51	193	0.56	193	0.51	193	0.49	193	0.48
2008	121	0.88	121	0.57	121	0.42	121	0.49	121	0.47	121	0.53
2009	18	−0.12	18	0.01	18	−0.11	18	−0.18	18	0.06	18	−0.03
2010	89	0.44	89	0.38	89	0.35	89	0.28	89	0.39	89	0.63
2011	109	0.48	109	0.36	109	0.40	109	0.73	109	0.74	109	0.57
2012	89	1.67	89	0.92	89	0.79	88	0.61	88	0.57	88	0.70
2013	106	0.85	106	0.70	106	0.59	105	0.47	105	0.46	105	0.57
2014	168	1.28	165	0.88	165	0.65	159	0.48	150	0.48	133	0.50
Totals	3736	0.92	3731	0.61	3731	0.50	3718	0.41	3701	0.39	3650	0.47

Table 3

Abnormal Returns Around Lockup Expiration

Table shows the average cumulative abnormal return ("CAR") over each specific time period. Time period days represent the number of trading days relative to the lockup expiration date. The 1988-1997 time period mirrors the sample period analyzed in Field and Hanka (2001). (***) indicates figures are significantly different from zero at a 99% confidence level

	CAR%					
	1988-1997		**1998-2014**		**1988-2014**	
Period	**Mean**	**TStat**	**Mean**	**TStat**	**Mean**	**TStat**
Day -50 to -6	0.51	0.76	−1.75	−2.89***	−0.79	−1.76
Day -5	0.05	0.41	−0.21	−2.12***	−0.10	−1.36
Day -4	0.16	1.36	−0.22	−2.06***	−0.06	−0.73
Day -3	−0.32	−2.66***	−0.12	−1.21	−0.21	−2.68***
Day -2	0.02	0.18	−0.22	−2.42***	−0.12	−1.62
Day -1	−0.20	−1.81	−0.38	−4.04***	−0.31	−4.24***
Day 0	−0.88	−7.18***	−0.47	−4.32***	−0.64	−7.88***
Day +1	−0.31	−2.28***	−0.41	−3.84***	−0.37	−4.37***
Day -5 to +1	−1.66	−5.97***	−2.07	−8.29***	−1.90	−10.20***
Day -1 to +1	−1.43	−7.17***	−1.26	−6.98***	−1.33	−9.94***
Day +2 to +10	−0.00	−0.01	−0.38	−1.42	−0.22	−1.11
Day 0 to +50	−1.79	−2.66***	−2.66	−4.38***	−2.29	−5.07***
Day +11 to +50	−0.60	−1.01	−1.31	−2.36***	−1.01	−2.48***

Figure 2

CARs and Venture Capital funding

The chart show the cumulative abnormal return (CAR) for the 100 day trading day window around the lockup expiration. CARs for the overall sample, and subsamples for Venture Capital backed and Non-Venture Capital backed IPOs are each depicted in the chart.

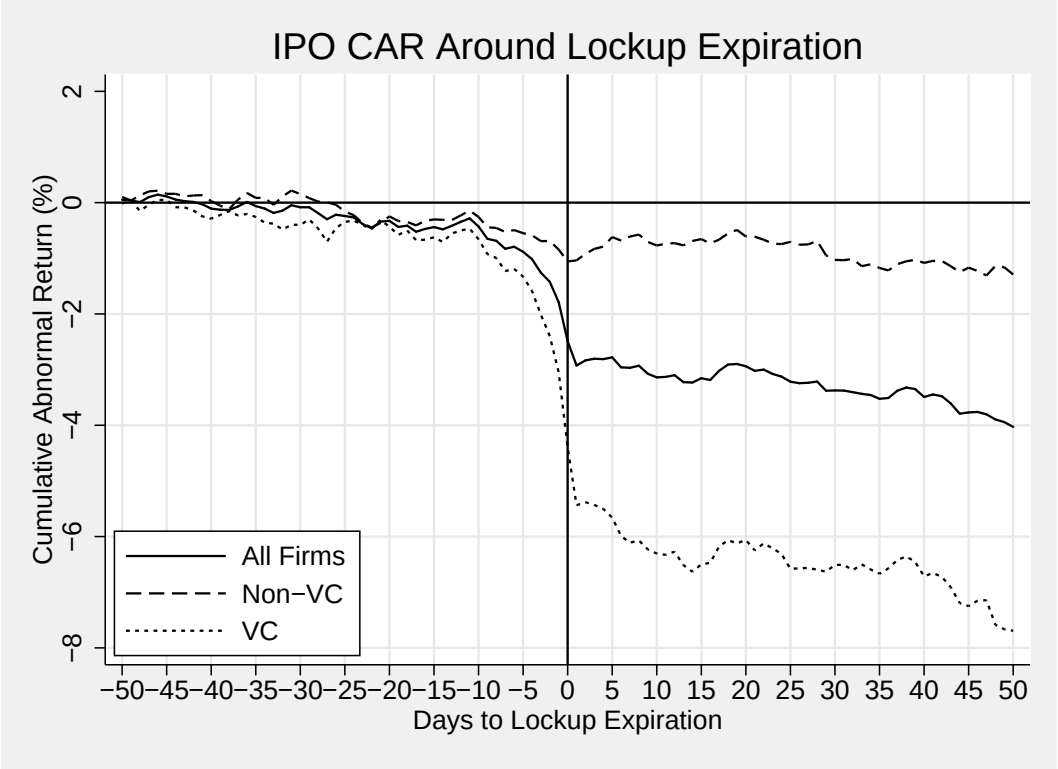


Table 4

CARs and Venture Capital funding

Table shows the average 3-day cumulative abnormal return percentage ("CAR") by year for the time period from 1988-2014. IPOs are categorized in the year which the lockup expiration occurred and are divided into two subsamples: firms with and without venture capital funding prior to the public offering. Neg is the percentage of IPOs in with negative CARs. Bid-Ask is the stock bid-ask spread divided by the stock price expressed as a percentage. (***) indicates figures are significantly different from zero at a 99% confidence level

	Not VC backed					VC backed				
Year	**N**	**CAR**	**TStat**	**Neg**	**Bid-Ask**	**N**	**CAR**	**TStat**	**Neg**	**Bid-Ask**
1988	6	−1.31	−1.12	66.67	3.87	11	−2.30	−1.43	63.64	3.03
1989	12	−1.84	−1.02	66.67	3.52	15	−1.75	−0.87	80.00	3.17
1990	31	1.08	1.09	45.16	4.85	37	−1.53	−1.50	64.86	3.77
1991	39	−0.07	−0.08	58.97	5.10	43	−3.90	−2.70***	72.09	3.55
1992	110	−0.88	−1.33	63.64	6.01	100	−2.26	−3.21***	64.00	6.27
1993	123	−1.07	−1.71	58.54	4.90	81	−1.01	−0.97	59.26	5.35
1994	168	−0.64	−1.37	62.50	5.57	120	−2.12	−2.79***	64.17	5.37
1995	103	−0.37	−0.61	58.25	4.28	76	−1.43	−1.53	51.32	3.34
1996	153	−0.28	−0.42	55.56	4.89	174	−2.97	−5.02***	65.52	4.27
1997	125	−0.95	−0.95	60.00	4.36	75	−3.91	−3.30***	76.00	4.24
1998	143	−0.84	−1.18	62.94	3.14	73	−2.42	−1.96	64.38	2.51
1999	62	0.71	0.63	43.55	2.84	55	−4.08	−2.36***	76.36	1.34
2000	54	0.31	0.17	55.56	2.26	125	−5.79	−4.83***	72.00	1.64
2001	19	0.38	0.14	47.37	2.22	54	−3.31	−1.18	62.96	2.16
2002	46	1.17	1.52	41.30	1.00	21	−2.30	−1.19	66.67	0.94
2003	40	0.37	0.78	47.50	0.55	8	−7.14	−1.24	62.50	0.82
2004	116	0.07	0.18	54.31	0.55	61	−2.49	−2.79***	68.85	0.69
2005	167	0.13	0.36	44.91	0.39	59	−3.13	−3.30***	69.49	0.56
2006	116	0.18	0.56	44.83	0.57	59	−2.24	−2.72***	66.10	0.84
2007	136	−0.55	−1.44	59.56	0.54	65	−1.91	−2.69***	66.15	0.48
2008	78	0.53	0.71	50.00	0.95	44	−3.78	−2.63***	56.82	1.86
2009	11	1.91	1.61	18.18	0.48	7	−1.79	−1.28	57.14	0.18
2010	64	−0.75	−1.66	65.63	0.44	25	−3.58	−2.27***	64.00	0.38
2011	65	−0.54	−0.60	61.54	0.92	44	−2.46	−3.14***	65.91	0.39
2012	49	0.61	0.97	46.94	0.41	43	−3.18	−3.53***	62.79	0.57
2013	66	0.69	1.18	46.97	0.55	42	−2.43	−2.26***	64.29	0.33
2014	66	−1.32	−1.45	60.61	0.62	104	−0.88	−0.92	55.77	0.53
Total	2,168	−0.27	−1.79	55.26	2.64	1,621	−2.75	−11.60	65.14	2.68

Table 5

Abnormal Short Sell Activity

This table shows the abnormal short sell volume (SV), short sell volume as a percentage of total volume (SVP) and total volume (TV) in the days surrounding the lockup expiration. Panels A and B include the Non-Venture Capital (VC) backed and VC backed IPOs, respectively. A total of 360 IPOs with a lockup expiration that occurs in the years 2012-2014 are included. Mean values are the single day average across all IPOs in the subsample. SV and TV figures are in thousands of shares. SVP is presented as a percentage. The firm level abnormal trading activity measure (ABV) is the trading activity as of day t divided by the 60-day average as of day $t-1$:

$$ABV(t) = \left(\frac{Vol(t)}{AvgVol(t-61,t-1)}\right) - 1$$

Panel A: Non-VC Backed IPOs

		SV		SVP		TV	
Day	**Obs**	**Mean**	**ABV**	**Mean**	**ABV**	**Mean**	**ABV**
−5	174	75.92	0.04	38.67	0.04	183.48	0.23
−4	174	88.81	0.26	40.89	0.10	215.55	0.13
−3	174	88.71	0.18	37.90	0.02	217.02	0.16
−2	174	83.46	0.25	39.41	0.07	187.40	0.07
−1	174	99.26	0.33	42.01	0.13	205.21	0.13
0	174	84.16	0.16	40.29	0.07	188.77	0.06
1	174	126.19	0.49	36.68	−0.01	308.20	0.67
2	174	91.62	0.23	35.34	−0.05	235.51	0.29
3	172	110.04	0.24	36.29	−0.02	266.75	0.42
4	172	96.20	0.09	35.25	−0.05	241.64	0.14
5	172	81.05	−0.03	37.18	−0.01	201.33	−0.05

Panel B: VC Backed IPOs

		SV		SVP		TV	
Day	**Obs**	**Mean**	**ABV**	**Mean**	**ABV**	**Mean**	**ABV**
−5	186	244.11	0.25	48.49	0.04	608.18	0.21
−4	186	263.16	0.15	48.27	0.03	632.62	0.10
−3	186	300.70	0.45	46.88	−0.00	715.05	0.51
−2	186	314.08	0.27	50.68	0.09	628.93	0.18
−1	186	352.24	0.45	52.07	0.11	694.87	0.27
0	186	761.09	0.93	47.63	0.02	1613.47	0.95
1	186	776.18	1.60	42.10	−0.10	2180.93	1.83
2	186	544.98	0.57	42.40	−0.09	1549.57	0.72
3	185	500.69	0.50	42.00	−0.11	1225.40	0.81
4	185	373.71	0.37	42.17	−0.10	948.10	0.47
5	185	332.12	0.21	41.05	−0.13	863.53	0.35

Figure 3
Non-VC and VC Backed IPO Trade Activity

The charts show the average daily trading activity around the IPO lockup expiration. Short volume is the total quantity of shares sold short, and short volume percentage is the total quantity of shares sold short divided by the total quantity of shares traded. Total volume is the number of shares traded.

Fig. 2.1 Average Daily Short Volume

(a) Non-VC Backed (b) VC Backed

Fig. 2.2 Average Daily Short Volume Percentage

(a) Non-VC Backed (b) VC Backed

Fig. 2.3 Average Daily Total Volume

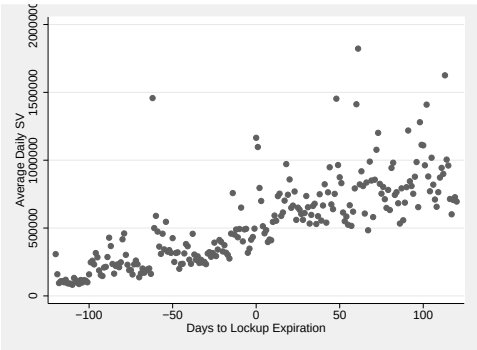
(a) Non-VC Backed (b) VC Backed

Figure 4

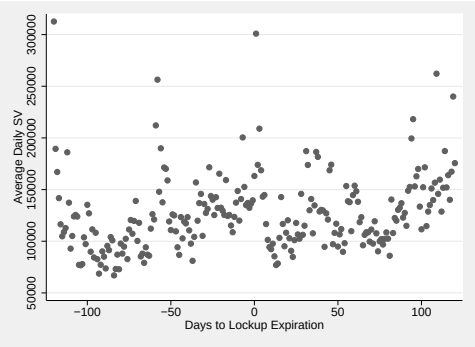
VC Backed IPO Trade Activity with +/- CAR

The charts show the average daily trading activity around the lockup expiration for the subsamples of Venture Capital backed IPOs with negative and positive 3-day CARs. Short volume is the total quantity of shares sold short, and short volume percentage is the total quantity of shares sold short divided by the total quantity of shares traded. Total volume is the number of shares traded.

Fig. 3.1 Average Daily Short Volume

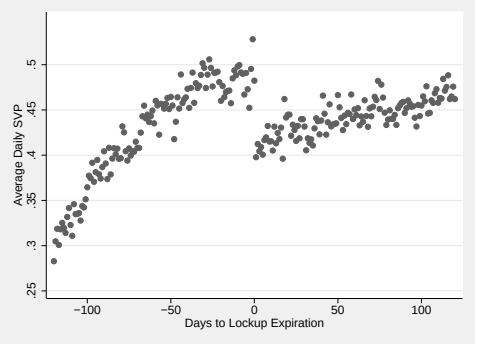


(a) Negative CAR

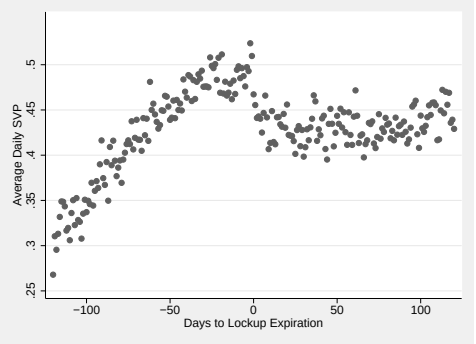


(b) Positive CAR

Fig. 3.2 Average Daily Short Volume Percentage

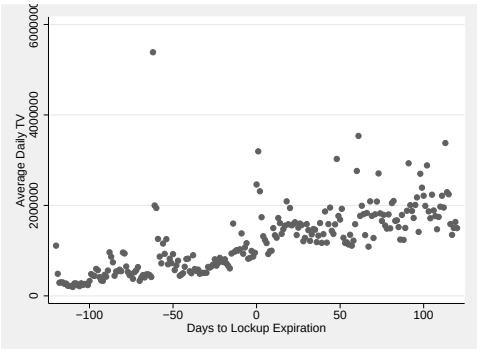


(a) Negative CAR

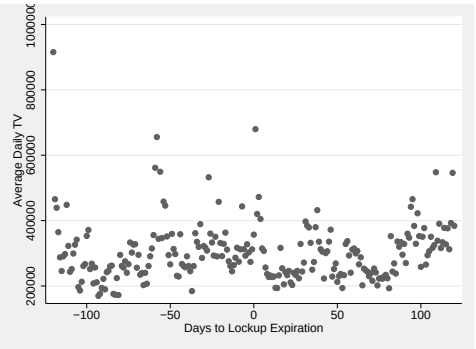


(b) Positive CAR

Fig. 3.3 Average Daily Total Volume



(a) Negative CAR



(b) Positive CAR

Table 6

CAR by Short Sell Trading Volume

This table includes 186 Venture Capital backed IPOs with expiration dates that occur from 2012-2014, the dates for which short sale volume is available. The table shows the average 3-day cumulative abnormal return (CAR) around the lockup expiration within quintile groups sorted by the average volume levels 5-days prior to the lockup expiration. Group 1(5) is the lowest(highest) volume group. HML (high-minus-low) is the Group 5 CAR minus the Group 1 CAR.

Panel A: Short Volume

	1-Day Avg		3-Day Avg		5-Day Avg	
Group	CAR	Tstat	CAR	Tstat	CAR	Tstat
1	−0.50	−0.27	0.37	0.22	−0.49	−0.31
2	−1.71	−1.30	−1.64	−1.03	−1.12	−0.67
3	−1.37	−1.16	−2.82	−2.61	−2.05	−1.73
4	−2.00	−1.46	−1.20	−0.96	−1.52	−1.25
5	−3.35	−2.94	−3.67	−3.01	−3.74	−3.05
HML	−2.86	−1.30	−4.04	−1.91	−3.25	−1.60

Panel B: Short Volume Percentage

	1-Day Avg		3-Day Avg		5-Day Avg	
Group	CAR	Tstat	CAR	Tstat	CAR	Tstat
1	−1.13	−0.78	−2.68	−1.87	−2.49	−1.51
2	−3.14	−1.96	−1.05	−0.65	−1.50	−1.31
3	−0.87	−0.69	−1.27	−1.07	−0.57	−0.39
4	−1.81	−1.55	−0.88	−0.60	−2.30	−1.66
5	−1.96	−1.30	−2.98	−2.37	−2.01	−1.49
HML	−0.82	−0.39	−0.30	−0.16	0.48	0.23

Panel C: Total Volume

	1-Day Avg		3-Day Avg		5-Day Avg	
Group	CAR	Tstat	CAR	Tstat	CAR	Tstat
1	−0.75	−0.51	−0.40	−0.26	−1.01	−0.62
2	1.92	1.39	0.98	0.69	0.58	0.38
3	−2.97	−2.78	−3.21	−2.59	−1.62	−1.36
4	−2.93	−2.14	−2.97	−2.59	−2.89	−2.30
5	−4.19	−2.79	−3.33	−2.24	−3.97	−3.24
HML	−3.43	−1.63	−2.93	−1.36	−2.96	−1.44

Table 7

CAR by Trading Volume

This table shows the average 3-day cumulative abnormal return (CAR) for the subsample of venture capital backed IPOs around the lockup expiration within quintile groups sorted by the average volume level the day prior to the lockup expiration. Group 1(5) is the lowest(highest) volume group. HML (high-minus-low) is the Group 5 CAR minus the Group 1 CAR. To account for potential volume level changes over time, stocks are grouped into quintiles in the year of the IPO lockup expiration.

	1-Day Avg		3-Day Avg		5-Day Avg		10-Day Avg		20-Day Avg		60-Day Avg	
Group	CAR	Tstat	CAR	Tstat	CAR	Tstat	CAR	Tstat	CAR	Tstat	CAR	Tstat
1	−2.94	−5.67	−3.21	−6.08	−3.25	−6.32	−3.54	−6.58	−3.32	−6.20	−4.13	−7.45
2	−3.31	−7.17	−3.01	−7.05	−3.74	−7.87	−3.20	−6.98	−3.09	−6.60	−1.95	−3.90
3	−2.94	−6.36	−2.88	−5.78	−2.34	−5.50	−2.69	−5.70	−2.05	−3.95	−2.32	−4.49
4	−2.37	−3.89	−2.61	−4.55	−1.36	−2.12	−1.80	−2.86	−2.05	−3.93	−2.46	−4.96
5	−2.19	−3.73	−2.04	−3.31	−3.08	−5.44	−2.54	−4.71	−3.30	−5.42	−2.96	−4.88
HML	0.75	0.96	1.17	1.45	0.17	0.23	1.00	1.32	0.02	0.03	1.18	1.44

Table 8

Summary Stats on IPOs with Traded Options

This table shows the summary stats for the subsample of IPOs with traded options at the time of the lockup expiration.

Issue Year	Total Obs	W/Opt Obs	%Total	VC %	% Shrs Sold	Mean Lockup
1996	251	1	0.40	0.00	39	180
1997	218	3	1.38	66.67	26	242
1998	111	1	0.90	100.00	39	180
1999	181	5	2.76	80.00	18	174
2000	119	2	1.68	50.00	18	180
2001	20	1	5.00	100.00	22	180
2002	64	5	7.81	0.00	35	180
2003	83	3	3.61	66.67	20	180
2004	226	11	4.87	27.27	37	213
2005	195	17	8.72	11.76	38	183
2006	153	14	9.15	28.57	25	188
2007	183	14	7.65	57.14	31	187
2008	20	5	25.00	0.00	37	180
2009	50	12	24.00	41.67	29	180
2010	100	20	20.00	35.00	34	179
2011	91	26	28.57	53.85	22	179
2012	104	26	25.00	57.69	24	194
2013	141	37	26.24	59.46	20	180
2014	91	24	26.37	62.50	20	180
Total	2401	227	9.45	46.70	26	185

Table 9

CAR for IPOs with Traded Options

This table shows the average 3-day cumulative abnormal return (CAR) around the lockup expiration for the subsample of IPOs with traded options at the time of the lockup expiration.

	Non-VC					VC				
Year	**Obs**	**CAR%**	**t-stat**	**Neg%**	**BidAsk%**	**Obs**	**CAR%**	**t-stat**	**Neg%**	**BidAsk%**
1996	0	.	.	.	.	0	.	.	.	.
1997	1	0.66	.	0.00	2.35	0	.	.	.	.
1998	1	−1.31	.	100.00	1.39	2	−8.12	.	100.00	0.61
1999	0	.	.	.	.	2	−7.08	.	100.00	0.45
2000	2	6.33	.	0.00	0.48	5	−3.01	−0.67	80.00	0.85
2001	0	.	.	.	.	1	−3.19	.	100.00	0.99
2002	7	−0.21	−0.15	71.43	1.06	1	−5.38	.	100.00	1.25
2003	1	4.18	.	0.00	0.36	1	−12.74	.	100.00	0.26
2004	4	1.54	4.26	0.00	0.13	2	−2.70	.	100.00	0.66
2005	14	1.06	1.03	28.57	0.26	2	−5.02	.	100.00	0.10
2006	11	1.69	1.10	27.27	0.31	4	−2.55	−2.27	75.00	0.46
2007	8	−1.10	−1.00	75.00	0.16	5	−4.63	−2.33	80.00	0.31
2008	8	1.76	0.73	37.50	0.30	5	−2.50	−0.96	60.00	0.22
2009	3	−0.54	−0.40	33.33	0.11	4	−0.54	−0.29	50.00	0.12
2010	7	−0.09	−0.08	57.14	0.11	2	−8.38	.	50.00	0.21
2011	19	1.52	1.22	52.63	0.11	14	−3.05	−2.11	64.29	0.15
2012	13	2.18	1.43	30.77	0.09	15	−5.57	−3.55	80.00	0.24
2013	7	1.79	1.51	28.57	0.06	13	−3.09	−2.14	69.23	0.11
2014	19	−1.78	−2.57	78.95	0.22	30	−2.05	−1.64	66.67	0.12
Totals	125	0.75	1.89	46.40	0.26	108	−3.47	−5.85	72.22	0.255

Table 10

IPO Lockup Portfolio Returns

This table shows the simulated portfolio returns for a hypothetical investment strategy in which the subsample of VC Backed IPO shares are sold short on day t=-1 and repurchased on day t=1, where t=0 is the lockup expiration date. Vol Max% is the maximum position size allowable as a percentage of the 5-day average trading volume. Portfolio returns for starting capital levels of 10K-10M are presented as a percentage return in the given year. Mkt is the annual return for the CRSP value-weighted index return and Rf is the annual return on an investment in 1 month Treasury bill rate. CAGR, SD, and Shrp are the compound annual growth rate, standard deviation and Sharpe ratio, respectively.

			Capital: 10K			**Capital: 100K**			**Capital: 1M**			**Capital: 10M**		
			Vol Max			**Vol Max**			**Vol Max**			**Vol Max**		
Year	**Mkt**	**Rf**	**1%**	**5%**	**10%**	**1%**	**5%**	**10%**	**1%**	**5%**	**10%**	**1%**	**5%**	**10%**
2002	−20.88	1.65	3.59	3.77	3.77	2.61	3.49	3.59	2.73	2.67	2.61	1.80	2.38	2.73
2003	33.15	1.05	6.27	6.50	6.50	2.18	5.91	6.27	0.92	1.27	2.18	1.04	0.98	0.92
2004	13.01	1.17	10.01	11.24	11.09	6.38	7.95	10.01	2.92	5.22	6.38	1.46	2.04	2.92
2005	7.30	2.99	12.65	15.49	18.50	8.03	11.01	12.65	4.45	6.70	8.03	3.15	3.78	4.45
2006	16.23	4.79	14.23	12.53	12.46	14.97	14.64	14.23	8.04	13.23	14.97	5.17	6.57	8.04
2007	7.36	4.65	13.59	13.64	13.64	11.37	13.41	13.59	5.61	9.28	11.37	4.91	5.27	5.61
2008	−38.14	1.59	16.35	17.47	15.30	9.39	13.94	16.35	3.38	6.46	9.39	2.47	2.90	3.38
2009	31.12	0.11	0.09	0.09	0.09	0.09	0.09	0.09	0.02	−0.21	0.09	0.10	0.06	0.02
2010	17.68	0.19	7.90	8.37	8.58	6.09	7.90	7.90	4.42	5.53	6.09	0.75	3.08	4.42
2011	−1.07	0.02	10.97	11.57	11.56	9.79	10.96	10.97	5.31	8.18	9.79	1.38	3.67	5.31
2012	15.75	0.02	10.67	12.21	13.05	8.68	10.36	10.67	5.21	7.62	8.68	2.61	4.59	5.21
2013	30.47	0.00	6.44	6.19	6.19	7.08	6.35	6.44	4.16	6.73	7.08	1.08	2.90	4.16
2014	10.53	0.00	9.45	6.38	6.38	15.10	14.46	9.45	7.60	13.44	15.10	1.24	5.00	7.60
CAGR	7.34	1.39	9.31	9.55	9.67	7.74	9.18	9.31	4.19	6.56	7.74	2.08	3.31	4.19
SD	20.30	1.73	4.52	4.94	5.09	4.55	4.50	4.52	2.30	4.03	4.55	1.54	1.78	2.30
Shrp	0.29	0.00	1.75	1.65	1.63	1.40	1.73	1.75	1.22	1.28	1.40	0.45	1.08	1.22

Table 11

IPO Lockup Portfolio Return Factor Analysis

This table shows the Fama-French-Cahart 4-factor regression results on the simulated portfolio returns in which VC backed IPO shares are sold short on day t=-1 and repurchased on day t=1, where t=0 is the lockup expiration date. Vol Max% is the maximum position size allowable as a percentage of the 5-day average trading volume. Portfolio returns for starting capital levels of 10K-10M are presented as a percentage return in the given year. $\alpha, \beta_{mkt}, \beta_{smb}, \beta_{hml}$, and β_{umb} are the coefficient estimates from the Fama-French-Cahart 4-factor regression below. T-statistics are listed below the coefficient estimates.

$$Ret_t - R_f = \alpha + \beta_{mkt} * (R_{mkt} - R_f) + \beta_{hml} R_{hml} + \beta_{smb} R_{smb} + \beta_{umb} R_{umb}$$

	Capital: 10K			**Capital: 100K**			**Capital: 1M**			**Capital: 10M**		
	Vol Max			**Vol Max**			**Vol Max**			**Vol Max**		
Factor	**1%**	**5%**	**10%**	**1%**	**5%**	**10%**	**1%**	**5%**	**10%**	**1%**	**5%**	**10%**
α	7.69	7.92	8.04	6.15	7.55	7.69	2.70	5.02	6.15	0.66	1.85	2.70
	5.38	5.28	5.25	5.68	5.53	5.38	5.08	5.40	5.68	3.52	4.62	5.08
β_{mkt}	−0.04	−0.04	−0.04	−0.03	−0.04	−0.04	−0.01	−0.02	−0.03	−0.00	−0.01	−0.01
	−7.17	−6.87	−6.76	−7.21	−7.26	−7.17	−5.02	−6.74	−7.21	−2.05	−4.06	−5.02
β_{smb}	−0.03	−0.04	−0.04	−0.03	−0.03	−0.03	−0.01	−0.02	−0.03	−0.00	−0.00	−0.01
	−3.17	−3.44	−3.40	−3.27	−3.19	−3.17	−1.93	−2.94	−3.27	−0.44	−1.33	−1.93
β_{hml}	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.00	0.00	0.01
	1.30	1.15	1.03	1.53	1.31	1.30	1.74	1.48	1.53	0.88	1.51	1.74
β_{umb}	−0.02	−0.02	−0.02	−0.01	−0.02	−0.02	−0.00	−0.01	−0.01	−0.00	−0.00	−0.00
	−2.54	−2.15	−2.04	−2.29	−2.64	−2.54	−1.22	−2.19	−2.29	−0.33	−0.90	−1.22
R^2	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.00	0.01	0.01