The Impact of Short Interest on the Performance of Tech Initial Public Offerings in the U.S.

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Abstract

This paper shows that short selling is an important component in the trading of initial public offerings. The finding goes against conventional wisdom in the IPO literature. Short sellers are informed traders who trade on negative information. Since their trades provide signals to the market, the short interest ratio serves as an indicator of subsequent low returns on a stock. This paper studies data on IPOs in the technology sector issued on the Nasdaq and NYSE between October 2007 and December 2015. The multiple regression analysis in this paper evaluates the performance of returns on tech IPOs based on many variables, including book-to-market ratio, market premium, and firm size. The results provide evidence that the average tech IPO exhibits a negative relationship between short interest ratio and abnormal monthly returns during the first year of trading.

1. Introduction

As Welch and Ritter (2002) set forth in their distinguished work on initial public offerings, one of the longstanding puzzles in financial economics is the short-term over performance and long-term underperformance of initial public offerings. There is empirical evidence that immediately after a newly issued stock starts to be traded, short selling occurs. Multiple explanations proposed by past literature focus on the impediments to short selling in the IPO aftermarket. The premise that short selling is difficult to carry out immediately after an IPO is based upon the perceived high cost of borrowing shares, as argued by Ljungqvist, Nanda, and Singh (2006). Others such as Ofek and Richardson (2003) claim that the lockup of insider shares leads to a restricted supply of shares trading in the IPO aftermarket, thus limiting the possibility of short

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selling. However, Edwards and Weiss (2010) assert that despite the impediments to borrow IPO shares, a surprising 99.5% of the American IPOs in their sample involve shorting those shares on the first day of trading and the majority of offer-day short sales occurs at the opening of trade.

A large body of finance literature has identified various models to explain the initial returns of IPOs in short-sale constrained settings but there is a relative dearth of literature dedicated to the relation between short interest and return performance of IPO stocks. Aggarwal et al. (2002) have found that trading volume and initial return are significantly correlated. Building on that prominent finding, there has also been noted a high degree of correlation between short selling as a percent of shares offered, trading volume as a percent of shares offered, and initial returns. Edwards and Weiss (2010) demonstrate that short sales on the first trading day comprise over 7% of the shares offered and 12% of the trading volume and that the largest amount of short selling occurs close to the open, despite the assumed impediments to short selling well-documented in other literature. Given these striking results, the magnitude and timing of shorting IPO stocks reveal that short selling is an integral part of the aftermarket trading of IPOs.

Short sellers are informed traders who make prices more efficient by trading on negative information. Under the information hypothesis, high levels of short interest in certain stocks signal to investors that those stocks are overvalued. This implies that the level of short interest is related to fundamental information about the stock and gives short sellers a role in making prices more efficient. Past empirical work has documented mixed results on the impact of short interest on return performance of stocks but some literature has noted that high levels of short interest may predict negative abnormal returns. In particular, Asquith et al. (2005) find that stocks with large amounts of short interest and low institutional ownership rates subsequently earn abnormally low returns. These findings suggest the information of short sellers could affect the relation between short interest and returns of a mature stock. The main point at the heart of this paper, then, is to examine whether the short interest ratio of tech IPO stocks can explain the variability in returns of a stock with no prior trading history.

The model formulated in this paper stresses the level of short interest as a key indicator of IPO performance during the lock-up period and first year of trading. An initial public offering is a complex process, which includes the first day of trading as a key signal of how the market reacts to newly issued stocks and the lock-up period as a time frame to analyze the volatility of initial returns. Ofek et al. (2000) highlight that after an IPO, insiders and pre-IPO shareholders are subject to a lock-up period in which they are not allowed to sell their shares for typically 180 days. When the lock-up period expires, there is an impressive shift in the supply of shares. They investigate the volume and pricing patterns during this period to show a significant drop in stock price and increase in trading volume. These authors argue that there is an anomalous price effect at the end of the lock-up period, which constitutes strong evidence in favor of demand curves for shares being downward-sloping. More interestingly, the magnitude of the price drop is related to the stock's underlying volatility. Considering that short sellers decide to short

stocks whose prices they predict will fall, the expiration of the lock-up period presents an opportunity to examine the short interest ratio and pricing movement of a stock.

The primary objective of this paper is to study the relation between short interest and subsequent returns of IPO stocks in light of Edward and Weiss's findings: short selling in newly issued stocks is not as constrained as frequently cited in past literature, suggesting that short interest may be used as a measure of performance of IPO stocks in the aftermarket. This model has the advantage of incorporating the three-factor time-series regression analysis by Fama-French to understand the characteristics of high-performing and low-performing IPO stocks in relation to their level of short interest. We start with a literature review, surveying previous work on short selling activity and trading of newly issued stocks in the immediate aftermarket of IPOs. In Section 3 and 4, we present a model that employs the Fama-French three-factor analysis to assess the impact of short interest on IPO returns. This opens a discussion of results and empirical support in Section 5. Finally, Section 6 concludes the paper.

2. Literature Review

This paper draws from detailed literature on the pricing and returns of initial public offerings as well as short selling activity in the stock market. One of the most prominent puzzles in finance is the significant underpricing of IPOs on the first day of trading. Ljungqvist et al (2004) study the theory and empirical evidence of IPO processes in depth and find that numerous initial public offerings in the United States are underpriced. Considering this significant level of underpricing, Ritter (2000) coined the term "money left on the table" – the number of shares sold times the difference between the first-day closing market price and the offer price – to refer to a wider debate on the efficiency of pricing mechanisms of IPOs. The average initial public offering in the United States leaves $9.1 million on the table, an amount equal to years of operating profits for many of the companies going public and an amount equal to approximately twice the direct fees paid to underwriters. This striking finding brings both the accuracy of firm valuation and the underwriters' fundamental pricing motives into question.

In order to investigate the pricing of newly issued stocks, Lowry et al. (2010) provide a new metric, the volatility of initial returns, to find that the variability in initial returns differs drastically across sectors of newly issued stocks from 1965 to 2005. In particular, stocks in the tech sector experienced more fluctuations in initial returns following an IPO. A significant proportion of technology IPOs faced higher uncertainty in firm prospects and these new issuances in the tech sector were thus more inherently difficult to value. In the same vein of interest, this paper surveys a sample of tech firms ranging from application software and hardware to green technology that went public between 2007 and 2015. Moreover, the process of initial public offerings present a unique event to explain the performance of stocks with no prior trading history that are fresh on the stock market, as noted by Brav et al. (2003).

One of the most contested branches of IPO literature is the rampant underpricing of initial public offerings on the first day of trading that is subsequently reversed in the short-term. A common assumption that is key to numerous models assessing IPO underpricing is the emphasis on short sale constraints. Ofek and Richardson (2003) strongly support the view that high costs of borrowing newly issued shares and the limited supply of shares during the lockup period leads to restrictions on short selling in initial public offerings. But recent studies bring the argument of IPO short selling constraints into question. Although IPO stocks are initially more expensive to short in the first month of trading, the overall cost of shorting is fairly small at around 3% at issuance, as determined by Geczy et al. (2002). In opposition to Ofek et al. (2003), these authors contend that the perceived high cost of shorting shares around lock-ups does not act as a significant barrier to short selling. More importantly, their paper is one of the first contributing to literature that suggests the activity of short selling occurs earlier in the IPO process than previously supposed.

Given this recent literature on short selling in IPOs, the underpricing phenomenon of stocks in initial public offerings begs the question whether IPOs with greater underpricing face more short selling than other IPOs. Edwards et al (2004) argue that stocks characterized by greater underpricing at the time of going public are subject to greater swings in short interest in the immediate and short-term. This finding is part of a larger empirical literature that links the role of short interest to the returns of stocks, beginning with Meulbroek et al. (1995) and Desai et al. (2002). These authors realize that monthly abnormal returns for stocks with high short interest on the NYSE and Amex Stock Exchanges for 1976–1993 and Nasdaq for 1988–1994 are negative and statistically significant. Similarly, Angel et al. (2003) conclude from proprietary Nasdaq data that high daily short sales are followed quickly by negative abnormal returns over a three-month period in late 2000. Taken together with the previous papers, existing literature gives consistent evidence that high short interest is proceeded by lower stock returns. A central question, then, is how the level of short interest, influenced by firm-specific and market-wide factors, can be used to measure the return performance of IPOs.

A growing body of papers has shed some light on this question by proposing models that link the level of short interest with subsequent returns in a demand-supply framework. The variables defined in these models can be largely separated into two classes: those that use proxies for demand of short selling and those which explain the supply side of short selling. The first set includes a variety of parameters such as the dispersion of analyst forecasts to represent heterogeneous beliefs. Gopalan (2003) finds that the greater the dispersion of analyst forecasts, the lower the returns for high short interest stocks on the NYSE and Nasdaq from 1992–2000. In addition to examining the divergence of investor opinion, Boehme et al. (2004) use market capitalization as a proxy for the difficulty of shorting. They report that the underperformance of stocks with a high short interest ratio is concentrated among small-cap stocks on the NYSE and Nasdaq in the 1990s. The common thread in these papers is their focus on measuring short selling activity using demand variables or supply variables, or a combination of both.

The practice of short selling – borrowing a stock from another investor to sell it immediately and close the position in the future by buying and returning the stock – has drawn the attention of many scholars. The investor community often references short interest as a predictive signal of share price performance. Typically, a high short interest indicates that more investors borrowed the stock betting that the price will fall in hopes of closing out the short position with a profit. Brent et al. (1990) explain why certain securities have a higher propensity to be held short and offer reasons such as tax motivations, speculation, and arbitrage. Other studies of short sales examine the investment strategy of buying or selling securities that have varying levels of short interest. Hurtado-Sanchez (1978), Figlewski (1981), among other papers, use different methods to assess whether short interest has predictive power for future returns. The results in these papers are mixed. Some support a predictive relation while others find no significant relationship.

In the realm of initial public offerings, the literature remains inconclusive on the presence or impact of short selling on the pricing and returns of IPOs. Nevertheless, Edwards and Weiss (2010) determine that short selling is not as constrained as suggested by the literature. In fact, 99.5% of the IPOs in their sample involve shorting those shares on the first day of trading and the majority of offer-day short sales occurs at the opening of trade. They therefore argue short selling is an integral part of the aftermarket trading of IPOs, showing that a higher amount of short selling occurred in IPOs with greater underpricing. We extend this key finding in this paper to examine the relation between the level of short interest and performance of newly issued stocks. In Section 3 and 4, we present the model, defining the variables and time frame; the discussion that follows in Section 5 considers the significance of the results and broader implications for existing literature and Section 6 concludes.

3. Theory

Suppose that abnormal returns of a stock can be modeled by the three-factor regression provided by Eugene Fama and Kenneth French (1996).

$$r_{it}-r_{ft} = a + \beta_M (r_{mt}-r_{ft}) + \beta_{SMB} SMB_t + \beta_{HML} HML_t + \varepsilon_{it}$$

where the variables are defined as the following:

a) $r_{it}-r_{ft}$ is the abnormal return, equal to the return of a stock i minus the risk-free rate in time period t,

b) $r_{mt}-r_{ft}$ is the market risk premium in period t, where r_{mt} is the value-weighted return of all CRSP firms incorporated in the US and listed on the NYSE, AMEX, or Nasdaq,

c) SMB_t is the return on a portfolio of small stocks less the return on a portfolio of big stocks in period t, provided by Kenneth French,

d) HML_t is the return on a portfolio of high book-to-market stocks less the return on a portfolio of low book-to-market stocks in period t, provided by Kenneth French.

Note that the Fama-French model builds on the Capital Asset Pricing Model (CAPM) and extends it with two additional variables. The excess return of the market index, r_{mt}-r_{ft}, plays a role in predicting the return performance of a stock as it is expected to capture systematic risk originating from macroeconomic conditions.

In addition, Fama and French introduce two firm-specific variables SMB_t and HML_t in their model due to long-standing empirical observations that firm size and the book-to-market ratio can explain abnormal returns of a stock. For instance, they point out that small firms may be more sensitive to changes in business conditions than large firms and firms with high book-to-market ratios are more likely to be in financial distress than firms with low book-to-market ratios.

The factor betas, β_M, β_{SMB}, and β_{HML}, then, measure the sensitivity of stock i to the three factors by estimating the factor beta values from regression analysis. These factor betas should as a group predict the total risk premium associated with a stock i.

The Fama-French model allows us to borrow the previous three variables outlined in b through d in order to incorporate them as control variables. Thus, we integrate the Fama-French model with the level of short interest as a dependent variable. The basis of our model is to find a relation between the returns performance and the level of short interest of tech IPO stocks.

4. Model

Suppose that the independent variable is the abnormal return of an IPO stock, equal to the actual return minus the risk-free rate in time period t. When defining the dependent variable, we realize it is necessary to standardize the absolute number of shares held short, either by way of the short interest ratio or short interest as a percentage of float. For the functionality of this model, we employ the short interest ratio as the dependent variable following the Nasdaq definition: the total number of shares shorted divided by the average daily trading volume.

With our central variables established, we find the impact that the short interest ratio of an IPO stock has on the returns performance. Furthermore, control variables are fundamental in regression analysis. We employ a multiple regression model that integrates control variables (r_{mt}-r_{ft}), SMB_t and HML_t provided in the three-factor Fama-French model with the short interest ratio as the dependent variable.

4.1 Multiple regression

We can estimate the abnormal return, $R_{it} = r_{it}-r_{ft}$, by the following multiple regression equation:

$$R_i = a + \beta_{SI}\, SI_t + \beta_M\, (r_{mt}-r_{ft}) + \beta_{SMB}\, SMB_t + \beta_{HML}\, HML_t + \varepsilon_{it}$$

In this regression model, the parameters to be estimated from the data are β_{SI}, β_M, β_{SMB}, and β_{HML}. We valuate these parameters by applying an ordinary least squares approach.

4.2 Time period

Suppose time period t is on a monthly basis. Since the data on short interest ratio is publicly available on an end-of-month basis, this model uses end-of-month abnormal returns and also adjusts the control variables to end-of-month. We find the monthly abnormal return as the actual monthly stock return in excess of the risk-free rate given by the 1-month U.S. Treasury Bill.

Assume the three time frames of interest in this paper are the first month of trading, the lock-up period of 180 days, and the first year of trading of IPO stocks.

To analyze the first month of trading, we consider the underpricing effect on the IPO offer day when the newly issued stock starts trading in the aftermarket. Note that the underpricing effect of an initial public offering can be measured by the return r_i on the first day of trading, where P_0 is the initial offer price and P_1 is the closing price:

$$\mathrm{ri} = \frac{P_1 - P_0}{P_0}$$

The higher the stock return r_i, the greater the underpricing effect on the first day of trading.

As the primary objective of short sellers is to sell high and buy low, they may respond to the offer-day underpricing of a stock by shorting the stock in the immediate IPO aftermarket. This leads us to construct the first proposition of the paper.

Proposition 4.2.1 *IPOs with greater underpricing on the first day of trading face higher initial short interest ratios in the first month of trading than IPOs with no underpricing effect.*

Following and including the first month of trading, a newly issued stock is subject to the lock-up period, a contractual restriction that prevents insiders and pre-IPO shareholders from selling their shares for a period usually lasting 180 days after the company goes public. When the lock-up period ends, shareholders previously limited under the lock-up can freely trade their stock, resulting in a larger quantity of shares available on the market.

The end of the lock-up period presents a key event in the IPO process, setting up the following proposition.

Proposition 4.2.2 *Following the lock-up period, IPO stocks face a fall in the short interest ratio.*

There are two potential reasons for a fall in short interest ratio to occur, either due to an increase in average trading volume or a decrease in the total number of shorted shares. Therefore, it could be that upon lock-up expiration, there is a substantial increase in average trading volume as noted by Field et al. (2001), or alternatively more short sellers are closing out their positions after the lock-up, decreasing the number of shorted shares.

Empirical evidence suggests that high short interest is negatively correlated with lower subsequent monthly returns for stocks with a long trading history. This allows us to consider whether a similar correlation can be found during the first year of trading of IPO stocks in Proposition 4.2.3.

Proposition 4.2.3 *Over the course of the first year of trading, IPO stocks with higher short interest ratios have lower subsequent monthly returns.*

4.3 Firm characteristics

Proposition 4.3.1 *Smaller firms face higher short interest ratios and thus exhibit more negative excess returns than larger firms.*

5. Results

To apply the general regression model, this paper surveys a sample of firms that issued initial public offerings in the technology sector in the United States. This sector comprises a category of stocks relating to the research, development, and production of technologically based goods and services. Building on this broad definition by Bloomberg Terminal, we evaluate IPOs in various tech subsectors: application software, computer hardware and storage, infrastructure software, semiconductor manufacturing, and greentech. Unexpectedly, a few greentech IPO stocks trade over-the-counter (OTC) rather than through a national public exchange. The data collection on returns and prices of these over-the-counter IPOs is not readily accessible to non-investors so OTC stocks end up dropped from the sample. We therefore include IPO stocks traded on the Nasdaq and New York Stock Exchange (NYSE).

Beginning in September 2007, the SEC requires all registered companies to report short interest at mid-month and at end-of-month. We thus consider tech IPOs issued between October 2007 and December 2015. Data on the absolute number of shares shorted, average daily volume, and short interest ratio is collected from Bloomberg Terminal.

End-of-month returns and prices are taken from the monthly stock files found in the Center for Research of Security Prices database (CRSP). Furthermore, monthly values for the three control variables in our model are available online in the Fama-French Data Library at Tuck Business School, Dartmouth University.

Our sample only includes tech IPOs for which there is both complete data on end-of-month short interest ratio from Bloomberg Terminal and monthly returns and prices from CRSP for the first year of trading. Then, performing crosschecks with Bloomberg Terminal and the online resource iposcoop.com, we compile a final sample covering 96 technology IPOs listed on the NYSE and Nasdaq between October 2007 and December 2015. After constructing the final sample, we present the results from this restricted sample in the next section.

5.1 First year of trading

To analyze monthly abnormal stock returns in relation to short interest ratios, we set time period t in the regression model equal to the first year of trading for all 96 stocks. We run the time-series regression 96 times for each individual stock. Then, we evaluate the return performance of the average firm in the sample, taking the average coefficient values of each factor and the relevant average standard errors. The regression results follow in Table 1.

The significance of our regression results is impacted by the calculation of the means. As we take the average of the factor beta values, we also take the average of the standard errors associated with the variables. Standard errors produced from ordinary least square regressions are statistically correct when the residuals are independent and identically distributed, but this condition may not hold when a panel data set contains observations on multiple firms from multiple years. Consequently, the standard errors can be biased and either over or underestimate the true variability of the beta estimates (Peterson, 2009).

In our case, the problem is that the bias lies in the way we address the standard error across all 96 firms. The means calculation approach we employ implies a debate on the statistical precision of the data. On one side, a widely used method is to run cross-sectional regressions each time period and then take the time series mean and standard errors of the regression coefficients (Fama-Macbeth, 1973). On the other hand, time-series regressions are commonly used to explain the cross-section of returns (Fama-French, 1996). For the purpose of this model, we follow the latter approach and consider mean standard errors that correspond to mean coefficient values in order to better understand the return performance of the average tech IPO.

	Intercept	Short Interest Ratio	Mkt-r_f	SMB	HML
Average coefficient	-0.021162552	-0.003283528	0.010268904	0.008595297	-0.000931861
Average standard error	0.090600829	0.01994176	0.014914038	0.025442113	0.025783864

Table 1

Considering the average technology firm, we observe that the higher the short interest ratio, the lower the abnormal monthly returns. Although we find a relatively small coefficient value of – 0.00328 (Table 1), this result in the broader sense aligns with evidence found in Asquith et al. (2005). A high level of short interest in a stock, then, has a slight negative impact on its return performance so firms with high short interest ratios face low subsequent returns, as modeled by Diamond et al. (1987).

This negative relationship between short interest ratio and return performance of a stock could be explained by the apparent significance of informational content provided by short traders. Information asymmetry may affect the price setting process as short sellers signal the market by trading on negative information, so they are more likely to concentrate their positions in the firms that are most overvalued. As the informativeness of this signal increases in the magnitude of short interest, which is represented by a larger coefficient for the short interest ratio in this model, the corresponding abnormal return turns out negative. Empirical tests done by Desai et al (2002) strongly support this view that short interest is a bearish signal with a subsequent negative impact on return performance.

We now focus on the results of the following three Fama-French factors incorporated in the model: the market risk premium (Mkt - rf), the return on a portfolio of small stocks less the return on a portfolio of big stocks (SMB), and the return on a portfolio of high book-to-market stocks less the return on a portfolio of low book-to-market stocks (HML).

To better understand the role of the aforementioned Fama-French factors, we carry out the same regression as in Section 4.1 but omit the short interest ratio variable and report the outcomes on the estimation of the beta coefficients β_M, β_{SMB}, and β_{HML} in Table 2.

$$R_i = a + \beta_M (r_{mt}-r_{ft}) + \beta_{SMB}\, SMB_t + \beta_{HML}\, HML_t + \varepsilon_{it}$$

	Intercept	Mkt-r_f	SMB	HML
Average coefficient	-0.02098	0.009688	0.00905	-0.00167
Average standard error	0.050111	0.014057	0.023879	0.023848

Table 2

So far we have obtained average beta coefficients including the short interest ratio (Table 1) and excluding the short interest ratio in the model (Table 2). This enables us to perform a comparative statics analysis of the Fama-French factors (Figure 1).

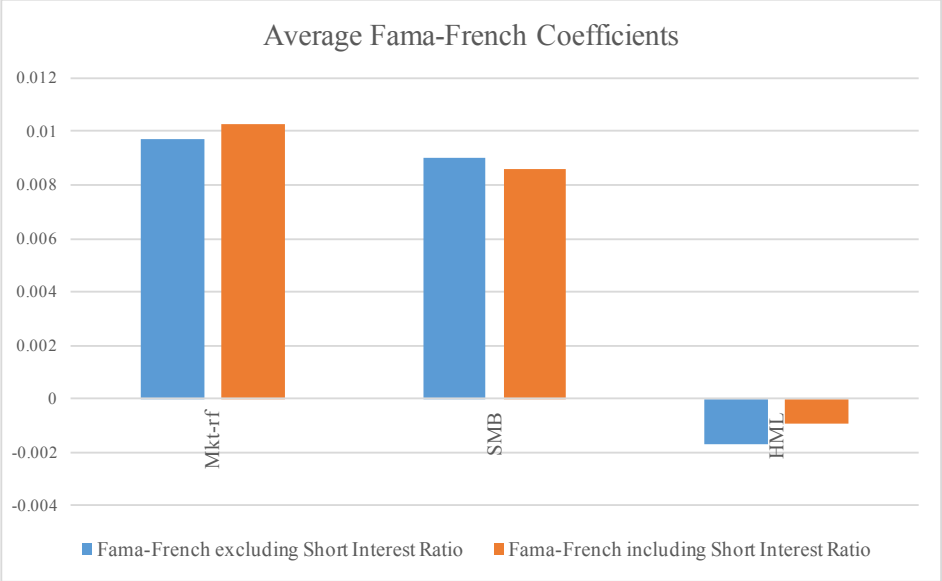

Figure 1

With the introduction of the short interest ratio in the model, the average beta for market risk premium increases slightly, while those for SMB and HML fall. Furthermore, it is striking that on average, the coefficient for HML is negative compared to the other factor coefficients. The changes in betas before and after the addition of short interest ratio are provided in Table 3 that follows.

Intercept	Mkt-rf	SMB	HML
+ 0.87%	+ 6.0%	- 5.0%	- 44.2%

Table 3

To deepen our analysis of the Fama-French factors, we consider each factor on an individual basis in relation to stock return performance.

The first factor, market risk premium, indicates the level of risk of a stock that can be explained by changes in the market, also known as systematic risk. The beta coefficient associated with this variable measures the responsiveness of a stock to the market. A beta of 1 implies a perfect direct correlation with swings in the market, whereas a beta of -1 means a perfect reverse correlation with market swings. The theory underlying the regression model prescribes a systematic and positive tradeoff between market beta and expected returns (Whitelaw, 2000).

Applying to our results, an overriding proportion of tech stocks exhibit a positive market risk premium beta (Figure 2) before and after integrating the short interest ratio in the model. The inclusion of the short interest ratio in the model also raises the estimated

coefficient by 6% (Table 3) although the number of observations for both negative and positive values does not change (Figure 1). A possible explanation is that the return performance of a stock is more sensitive to fluctuations in the market when accounting for changes in the short interest ratio.

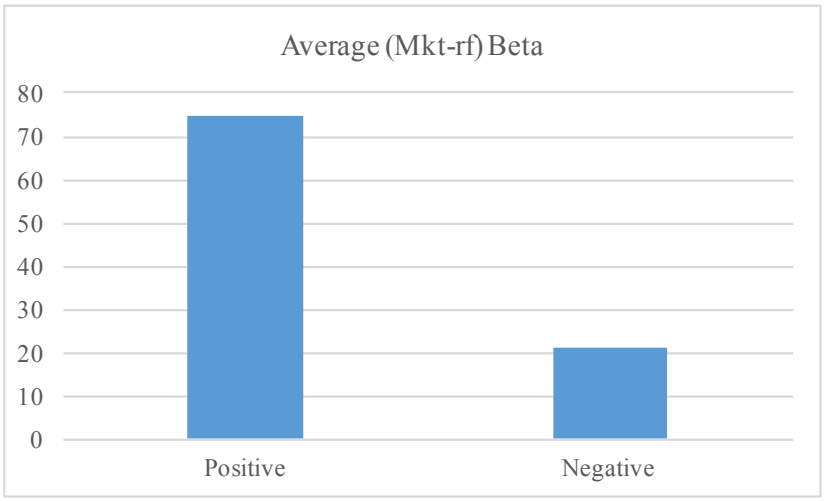

Figure 2

The use of a market beta may be justified as a measure of stock risk, even if it can be less efficient than alternative measures of systematic risk or is an incomplete measure of risk, as pointed out by Pettengill et al. (1995). Our model therefore integrates non-systematic factors such as firm size and book-to-market ratio to understand the returns variability of the average tech IPO on a firm-specific level.

There is substantial variation in the types of firms that go public. Some operate for decades, while others are young start-ups. Aside from a firm's history, size is a key indicator in finance to control for differentials in returns arising from differences in market capitalization. The variable SMB developed by Fama-French represents the return on a portfolio of small stocks less the return on a portfolio of big stocks. We see that the associated beta coefficient is on average positive, although not by a clear majority (Figure 3). This beta value reflects the small firm effect, referring to the longstanding observation that small firms outperform large firms after controlling for CAPM-based risk, which stems from Banz's work (1981). Our regression result shows that the small firm effect is present for the average tech IPO as indicated by the positive beta coefficient but given its relatively small magnitude, this factor may not be the primary indicator of return performance.

Interestingly, adding the short interest ratio to the regression model decreases the average SMB beta by -5.0% (Table 3). This finding suggests that when accounting for the short interest ratio, the small firm effect plays a less important role in explaining abnormal returns of the average tech IPO in the first year of trading. Another interpretation of the fall in SMB beta could be that the underperformance of stocks with a high short interest ratio is concentrated among smaller stocks. Then, if larger firms are more actively followed owing to their size, short sellers are more likely to have an informational

advantage in smaller stocks. The results of Boehme et al. (2004) seem to be consistent with this possibility.

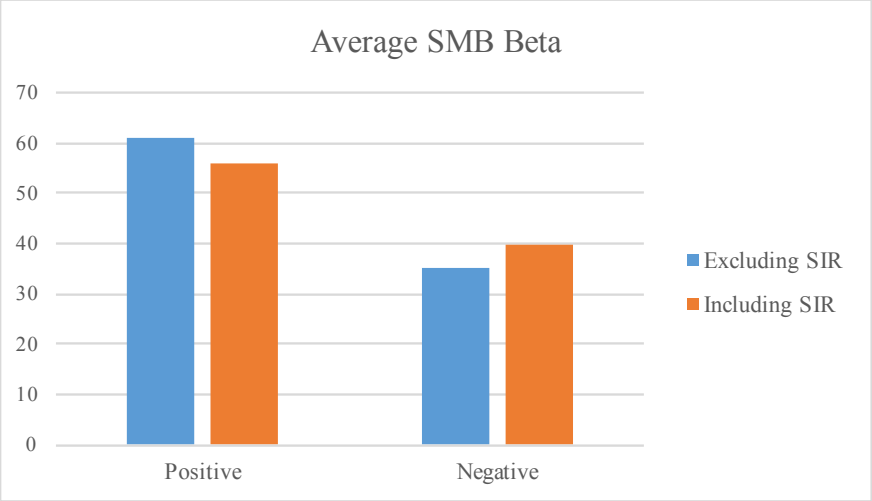

Figure 3

In addition to firm size, another firm-specific risk factor that we include in our model is HML, a measure of book-to-market ratio of a stock. It is widely known that firms with high book-to-market ratios are more likely to be in financial distress than firms with low book-to-market ratios. Moreover, stocks characterized by high book-to-market ratios, also classified as value stocks, historically outperform growth stocks, as pointed out by Fama and French (1996). The factor HML, then, measures the spread in returns between value stocks and growth stocks, where value stocks are typically characterized by high book-to-market ratios in comparison to growth stocks.

Our model yields a negative coefficient for HML indicating that the average tech IPO firm shows a tendency to experience abnormal returns as a growth stock (Figure 4). Extending this view, Ritter and Welch (2002) determine that the long-run underperformance of IPOs is most severe for small stocks that have low book-to-market ratios known as growth stocks. But the introduction of short interest ratio in our model surprisingly increases the HML coefficient by 44.2% (Table 3). This dampens the negative effect on abnormal monthly returns arising from the value factor HML, suggesting that the average tech IPO tends to behave like a value stock rather than a growth stock.

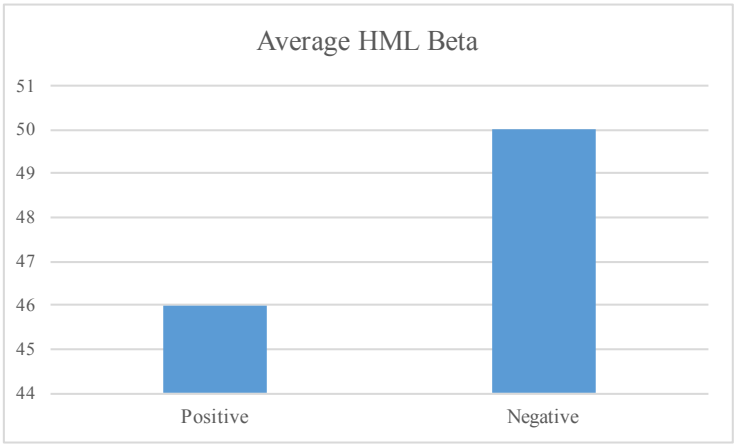

Figure 4

Aside from the betas associated with the short interest ratio and three risk factors, the intercept value obtained in the regression can reveal information about the validity of the model that we employed. According to theory, the Fama-French model assumes that if the three factors Mkt-rf, SMB, and HML accurately explain the abnormal returns of a stock, then the intercept, also known as alpha, should approximate to zero. If not, there might be for instance another risk factor priced in the stock but not reflected in the model.

The average tech IPO firm from our sample shows a negative intercept, which becomes more negative by 0.87% (Table 3) when the short interest ratio is incorporated in the regression. This lower alpha represents that a firm with higher idiosyncratic risk tends to underperform or alternatively, the average tech IPO performs worse than its beta predicts. However, taking the average intercept may not be the best method of evaluating the alpha of a stock especially if there is great variability in the underlying firm characteristics. Given that this paper surveys the technology sector which covers a wide span of subsectors and firms, this may be the case here.

Borrowing the variables of the Fama-French proposal to implement them in the IPO process is the first stage of our modeling. As shares of most IPOs are available to short as soon as the first settlement day, short sellers signal their assessment of a firm's true value in the market. The amount of short interest in a stock reflects the activity of short selling and consequentially can be considered an indicator of future price variability of a newly issued stock. The short interest ratio is defined as the amount of short interest in a stock divided by the average trading volume. Alternatively, it is called the days to cover a stock and represents the estimated amount of days it takes for all current short sellers in the market to buy back the shares that they borrowed from a broker. If there is an upward momentum in price of a stock with a high value for days to cover, the future buying pressure on the stock will rise.

We predict that IPO stocks with higher short interest ratios have lower subsequent monthly returns during the first year of trading (Proposition 4.2.3). Indeed, the model generates a coefficient associated with the short interest ratio that is negative (Figure 5). While a negative relationship seems to exist between short selling and future firm

performance, Asquith et al. (2005) and Cohen et al. (2007) remark that this relation is weak and driven mostly by a few small firms.

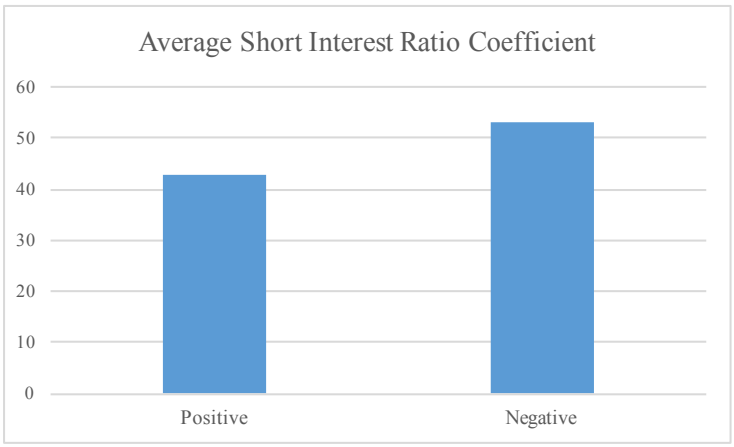

Figure 5

Overall, the regression results for the first year of trading suggest that the average American tech IPO post mid-2007 exhibits a slightly negative relation between short interest ratio and return performance accompanied by a positive market risk premium beta, a positive firm size beta, and a negative book-to-market ratio beta. Thus the return performance of an average tech IPO during the first year of trading resembles that of a small-cap growth stock. This interpretation is corroborated by Boehmer et al. (2010) who find that heavily shorted stock portfolios have relatively large market betas, a positive coefficient on SMB, and a negative coefficient on HML.

5.2 Lock-up period

In the prior section, we focused on a time-series approach to the data to understand the time variation of tech IPO returns during the first year of trading. Now we concentrate on the lock-up period, a cross-sectional of the time-series regression model that is unique to the IPO process. Upon expiration of the lock-up period lasting usually 180 days, company insiders and pre-IPO shareholders are allowed to sell their shares, which increases the supply of shares. Ofek et al. (2000) note that this shift in supply is accompanied by a drastic stock price drop. Although we lack data on the number of shares outstanding, we can note that there is a fall in abnormal returns for the average tech IPO between months six and seven by 47 percent, coinciding with the end of the lock-up period (Figure 6). The magnitude of this inter-month price drop signifies the average stock's fundamental volatility during the initial months of trading. In addition, the length of the lock-up reveals credible information pertinent to an initial public offering's riskiness. Mohan et al. (2001) find that a period of 180 days, roughly six months, may be regarded as a norm and this is the case for our sample of 96 firms. These authors conjecture that trading activities conducted soon after the expiration of the lock-up period signal the true firm value.

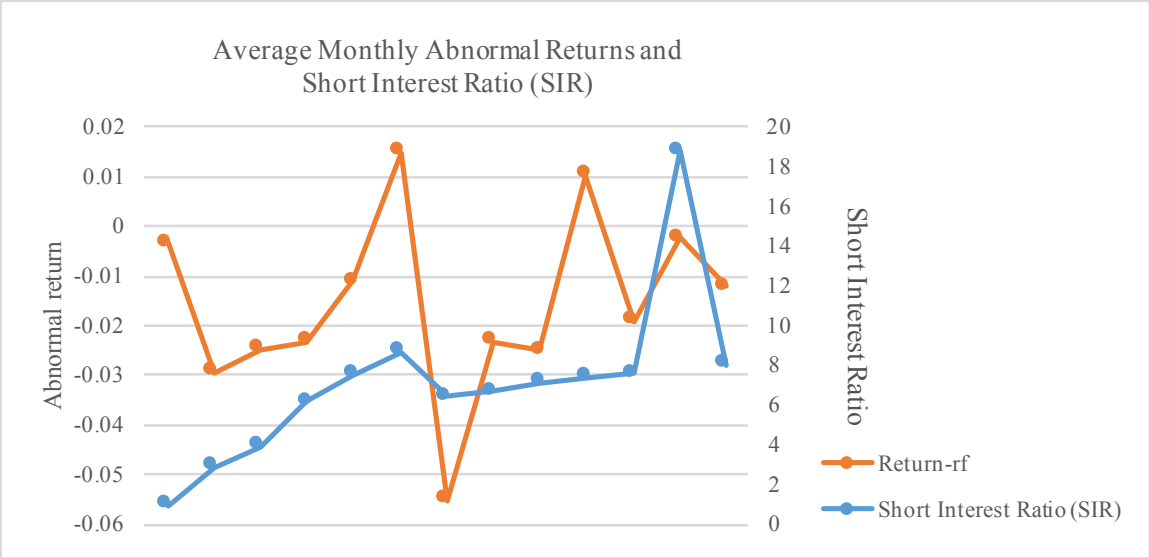

Figure 6

We observe a general upward trend of the short interest ratio for the average tech IPO stock during the first year of trading, but this value abruptly falls in month six, when the lock-up period ends, by 26 percent, accompanied by a fall in returns (Figure 6). While market participants with long stock positions do not gain from a general price drop, those with short stock positions seem to benefit from both a price drop and lower short interest ratio. Interpreted as the days to cover, a smaller ratio favors short sellers as it takes fewer days to buy back a stock to close out a short position. A fall in the short interest ratio implies either the amount of short interest decreases or the average trading volume rises. Whether one effect dominates the other or both effects occur simultaneously is an important distinction to be made and deserves greater attention in the existing literature.

5.3 First month of trading

The SEC does not publicly provide data on short selling on the first settlement day. However, data on the first month of trading offers us insight in the initial performance of an IPO. Considering a time-series approach to first-month data, we track and analyze the co-movement of short interest ratio and abnormal return of IPO stocks over the period spanning from October 2007 to November 2015. For every month in this time frame, the initial abnormal monthly return and short interest ratio are measured across all firms going public during that month. The cross-sectional mean of first-month abnormal return in Figure 7 suggests that the conditional distribution of IPO initial returns varies significantly over time, as similarly concluded by Lowry et al. (2010).

While the average initial return fluctuates over time, the average initial short interest ratio seems to present a wider dispersion. This greater volatility in short interest ratio shows the short sellers' activity in IPO stocks. The two variables, first-month abnormal return and short interest ratio, are inversely correlated, with a correlation coefficient of -0.302218607. This co-movement of the average and short interest ratio is consistent with

our prediction that a high short interest ratio negatively impacts the abnormal return of an IPO tech stock. Moreover, Asquith et al. (2005) point out that abnormal returns to heavily shorted stocks vary substantially over time, in contrast to lightly shorted stocks.

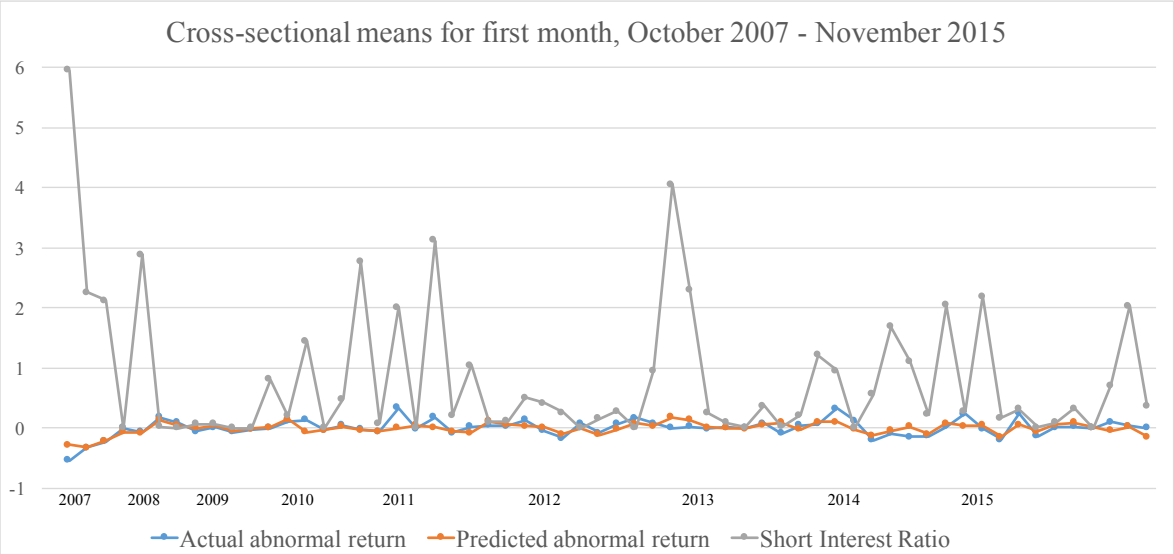

Figure 7

5.4 Subsector analysis

The tech IPO sample includes 96 firms spanning across an extensive array of subsectors (Figure 8). After sorting the sample data into subsectors, we analyze the return variability in relation to short interest and the risk factors from the point of view of specific subdivisions. We employ a similar method as in Section 5.1 but group IPOs into subsectors and calculate the mean coefficient values and relevant standard errors for all subsectors. This approach allows us to evaluate the return performance of the average tech IPO in each subsector and bears two advantages. First, we perform a comparative analysis of factor effects on stock returns pertaining to the five subsectors, and second, we use the results to extend the data of the first year of trading.

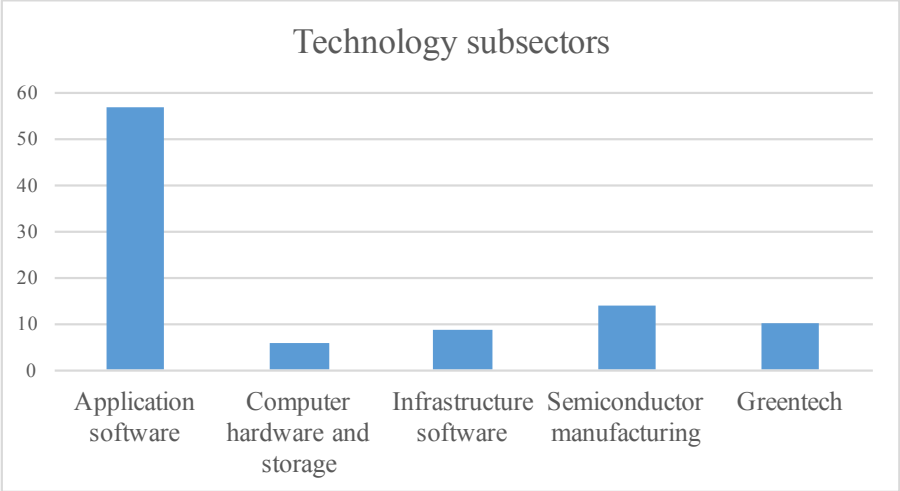

Figure 8

The data on the regressions means strongly indicates that out of the five subsectors, four clearly show a negative relationship between short interest ratio and returns performance (Appendix 7.1). They follow the same general trend as seen in the negative factor loadings: -0.0013526 for application software, -0.0077442 for greentech, -0.0048228 for infrastructure software, and -0.0118091 for semiconductor manufacturing. The exception is the computer hardware and storage sector that carries a positive beta for short interest ratio, implying that as the short interest ratio increases, the abnormal returns grow as well. One potential explanation for this apparent contradiction could arise from how we interpret the short interest ratio. If we believe that securities with high short interest ratios are more likely to increase in price as short sellers will have to buy back the security to cover their short positions, then a positive SIR coefficient corroborates this prediction. An alternative explanation for the exception could be that the sample size is too small since the subsector only contains six IPOs and is the smallest of all five groups. Despite the exception of the computer hardware and storage sector behavior, the data sorted in subsectors shows that IPO stocks with higher short interest ratios have lower subsequent monthly returns during the first year of trading and this supports our main prediction.

Additionally, we find a positive market risk premium beta for the average tech IPO in each of the five subsectors. A positive market beta reflects the level of systematic risk present for the average IPO in each subsector and affirms that tech IPO pricing swing with market returns.

Considering SMB, four of the five subsectors display a small firm effect as denoted by a positive coefficient with the exception of greentech IPOs. Carleton et al. (1986) observe significant differences in firm size across industries and also substantial differences in returns between industries. They thus conjecture that the small firm effect can be attributed to the joint effects of inter-industry differences and seasonality. Building on this hypothesis, a similar view can be established here. Despite the fact that our statistical procedure does not formally control for between-subsector or seasonal effects, we propose that the role of company size in IPO returns in the tech industry depends on subsector dynamics.

Unlike the previous factors, we obtain mixed results for the beta coefficient of HML. While two of the subsectors, greentech and semiconductor manufacturing, display a positive coefficient, the trend reverses for the remaining three subgroups: application software, computer hardware and storage, and infrastructure software. These varied results open a discussion on the risk premium assigned to stocks with high book-to-market ratios, a measure used to quantify the exposure of a stock to financial distress. Griffin et al. (2002) argue against a risk-based explanation of the book-to-market premium. In the context of tech IPOs, it seems that HML is not a decisive indicator of return performance. Consistent with this view, there is reason to believe that an alternate variable to the HML factor can be employed to distinguish the level of financial distress among IPO stocks and this possibility should be explored further in the literature.

6. Conclusion

This paper intends to convey the significance of short selling in newly issued stocks, offering empirical evidence that the short interest ratio has a negative impact on IPO return performance. The model provides extensive regression results to examine this relationship and also includes a time-series component and cross-sectional approach to better understand the return variability of tech IPOs in the U.S. It is commonly accepted that short selling is rarely practiced in the early IPO process. However, the data indicates the contrary.

We find that the average tech IPO exhibits a negative relationship between the short interest ratio and monthly returns during the first year of trading. This effect is emphasized in small companies with a high market risk premium, while the data remains inconclusive on the relation of book-to-market ratio on return performance. Sorting the sample in subsectors reinforces these results and depicts that tech IPO stocks with higher short interest ratios have lower subsequent monthly returns during the first year of trading. This supports the main proposition of our model.

The first month of trading and end of lock up period are two key points in the IPO process that particularly reflect the negative relationship between short interest and return performance. Despite varying overtime, a negative correlation exists between first-month return and short interest ratio. Furthermore, the fall in the short interest ratio at the end of the lock-up period coincides with a decline in subsequent monthly returns of an IPO. While short interest data on the first settlement day of a newly issued stock is not publicly available, the impact of short selling activity on first-day IPO underpricing is an important area for future research.

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7. Appendices

Appendix 7.1: Regression means in subsectors

Application software, first year of trading

	Intercept	Short Interest Ratio	Mkt-r_f	SMB	HML
Average coefficient	-0.0276815	-0.0013526	0.0110838	0.00959135	-0.0009737
Average standard error	0.0915934	0.02012534	0.15224623	0.02622385	0.02609847

Computer hardware and storage, first year of trading

	Intercept	Short Interest Ratio	Mkt-r_f	SMB	HML
Average coefficient	-0.0534142	0.00286452	0.01016802	0.00426145	-0.0076463
Average standard error	0.07820284	0.01719335	0.01540591	0.02473671	0.02591013

Greentech, first year of trading

	Intercept	Short Interest Ratio	Mkt-r_f	SMB	HML
Average coefficient	0.03087291	-0.0077442	0.00515331	-0.0022909	0.00623277
Average standard error	0.08594408	0.02153282	0.01517845	0.0244913	0.02624307

Infrastructure software, first year of trading

	Intercept	Short Interest Ratio	Mkt-r_f	SMB	HML
Average coefficient	0.01052782	-0.0048228	0.01136772	0.01190725	-0.0063453
Average standard error	0.08764359	0.01578602	0.01386488	0.02153286	0.02374089

Semiconductor manufacturing, first year of trading

	Intercept	Short Interest Ratio	Mkt-r_f	SMB	HML
Average coefficient	-0.0558518	-0.0118091	0.00875021	0.01067891	0.00446596
Average standard error	0.10071321	0.02493048	0.01407937	0.02773813	0.02636171