Pre-IPO Insider Ownership and Underpricing: High-tech versus Low-tech IPOs

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Current Draft: February 6, 2008

Abstract

Using data for 2,391 non-financial firm commitment initial public offerings (IPOs) between January 1996 and December 2002, we examine the relation between pre-IPO insider ownership and underpricing for high-tech and low-tech IPOs. Contrary to the conventional wisdom that suggests that firms in which insiders retain a higher proportion of insider ownership are generally less risky and thus less underpriced, we find that the relationship between insider ownership and underpricing differs between low- and high-tech firms. When high underpricing is expected, insiders of high-tech IPOs retain a high percentage of pre-IPO ownership. The opposite is observed for low-tech IPOs. To adjust for endogeneity biases, we use a simultaneous equations framework.

JEL Classification: G24; G32; G39
Keywords: Initial Public Offerings; Insider Ownership

1. Introduction

Initial public offerings (IPOs) represent an important method through which companies can raise capital. From an academic point of view, IPO underpricing – the offering of IPO shares to initial investors at a price that falls well below subsequent market prices – is commonly perceived as a contradiction to capital market efficiency. However, it is a common phenomenon that has been documented not only in the US but also in a number of other countries (Loughran et al., 1994). IPO underpricing is currently one of the most actively researched areas in corporate finance, with numerous studies offering explanations for the apparent anomaly. A large body of the financial literature suggests that IPO underpricing may be caused by basic problems derived from information asymmetry among various parties involved in the transaction. In this study, we focus our attention on the differences between high-tech and non-high-tech (low-tech) IPOs. During the late 1990s, the characteristics of high-tech and low-tech IPOs diverged to an unprecedented extent which in that magnitude has not been seen in prior IPO markets. One aspect of the hot IPO market of 1999/2000 that was highlighted by the press and the investment community during that period was the high underpricing of high-tech IPOs. A majority of high-tech firms had little revenues prior to their IPO and had yet to make any profit (Bartov et al. 2002). The main goal of this paper is to explore how the relationship between underpricing and insider ownership differs between high-tech and non-high-tech IPOs.

Some recent studies relate underpricing to the activities of underwriters in the aftermarket (Aggarwal, 2003), irrational behavior due to speculation bubbles and market fads (Loughran and Ritter, 2002) and naïve investors' overoptimism (Rajan and Servaes, 1997). Rock (1986) and Beatty and Ritter (1986) view the "winner's curse" that uninformed investors face as an explanation for the underpricing phenomenon. Informed investors always bid for securities that

are underpriced. On the other hand, investors who are relatively uninformed realize that they may be allocated overpriced IPOs; therefore, issuers have to underprice their IPOs to compensate them for ex ante uncertainty. The higher ex ante uncertainty, the more underpriced the IPOs.[1] Aggarwal, Prabhala, and Puri (2002) and Cornelli and Goldreich (2001 and 2003) find that investment bankers allocate more underpriced IPOs to their favorite institutional investors as an incentive for them to reveal information. Muscarella and Vetsuypens (1989) find that IPOs that have lower valuation uncertainty such as self-marketed IPOs and reversed leveraged buyout IPOs are less underpriced. Michaely and Shaw (1994) show that underpricing is lower in the market where uninformed investors know ex ante that they do not have to compete with informed investors.

On the other hand, Grinblatt and Hwang (1989), Welch (1989), and Allen and Faulhaber (1989) develop models based on signaling theory, which suggest that issuers deliberately underprice their shares to signal the true value of their firms. They explain that firms are willing to underprice their IPO because they expect to raise more money in the next round of financing. Jegadeesh et al. (1993) and Garfinkel (1993) test the signaling theory empirically but find no evidence to support it. Su and Fleisher (1999), on the other hand, employ Chinese IPO data and find evidence that supports the theory.

In this paper, we study the relationship between pre-IPO insider ownership and underpricing. Most of the extant literature on insider ownership and IPO underpricing has focused on one of two questions: 1) whether *pre-IPO* insider ownership is a useful predictor of

[1] See Koh and Walter (1989), Keloharju (1993), Amihud, Hauser, and Kirsh (2003) for evidence supporting the winner's curse hypothesis.

underpricing and 2) whether underpricing influences *post-IPO* insider ownership.[2] Our study differs from these two strands of the financial literature in that it explores whether and how the magnitude of *pre-IPO* insider ownership is affected by expected underpricing and, at the same time, how observed insider ownership affects subsequent underpricing.

This study contributes to the literature in several ways. Most importantly, we address the dynamic interaction between signals of underpricing and pre-IPO insider ownership. Previous studies have viewed the relationship as static and have analyzed each relationship separately in an OLS framework. In contrast, we account for potential endogeneity biases and use a cross-sectional, simultaneous equations approach to examine the interaction between these variables. Thus, our research design provides a better specified test to examine the interaction between the two factors and enables us to draw inferences with confidence. First, we hypothesize that non-high-tech IPOs with high pre-IPO insider ownership have high underpricing as proposed by the signaling theory. On the other hand, insiders that have low ownership in high-tech IPO firms have less incentive to monitor the degree of underpricing and thus underpricing is high. This can be explained by the typically more fragmented insider ownership of high-tech IPOs and the higher frequency and size of "friend and family" share allocations among these firms (Ljungqvist and Wilhelm, 2003). The lower level of pre-IPO insider ownership for high-tech firms is also documented by Huyghebaert and Van Hulle (2006). Second, we find that higher *expected* underpricing causes lower pre-IPO insider ownership for non-high-tech IPOs. Since underpricing is commonly perceived to be a signal of good firm quality and in this case is expected to be high, insiders will decrease their ownership to minimize their wealth loss from leaving money on the table. As such, our results provide additional support for Gomes (2000) and Habib and

[2] Brennan and Franks (1997), Stoughton and Zechner (1998), and Ljungqvist and Wilhelm (2003) examine how pre-IPO insider ownership affects underpricing whereas Field and Sheehan (2003) study how underpricing relates to post-IPO insider ownership.

Ljungqvist (2001) who argue that insiders retain less of their ownership when underpricing imposes costs.

Finally, we find that insiders of high-tech firms increase their pre-IPO ownership when they expect underpricing to be high. This finding is consistent with Loughran and Ritter (2002) who argue that underpricing is high following stock market runups and low after periods of declining index levels. They attribute this behavior to issuers who think that the personal wealth gain they experience as a result of the price increase of their retained shares exceeds the wealth loss that results from leaving money on the table. Insiders of high-tech firms will retain more ownership when they expect high underpricing because they think that their wealth will increase from a price jump in the first day more than the expected loss they experience from leaving money on the table. Moreover, underpricing may convey different information for high-tech and non-high-tech IPOs. This explanation is supported by Stoughton and Zechner (1998) who show that underpricing is high for companies that have high benefit-to-cost ratios from monitoring, such as high-tech firms. Since the benefits-to-cost ratio from monitoring is higher in high-tech firms than in non-high-tech firms, insiders of high-tech firms will increase their ownership when they expect high underpricing. Lastly, Ljungqvist and Wilhelm (2003) find that more IPO firms adopted directed share programs (DSPs) in recent years. Our results in Section 2.2 suggest that such DSPs were particularly popular among high-tech firms; as such, insiders of high-tech firms who expect high underpricing may either directly or indirectly increase their ownership by retaining more shares themselves or by allocating more shares to friends and family members who can benefit from purchasing underpriced shares. Moreover, they can take advantage of the IPO's high underpricing by flipping their shares in the first few days after the issue. Of course, some of them may be subject to lock-up provisions that restrict them from selling their shares

during the post-IPO lockup-period. Yet, studying 600 IPO firms with directed share programs that went public between January 1, 1999, and August 17, 2003, Ray (2006) finds that only two percent of the shares bought through DSPs were subject to such lockup restrictions.

2. Data description

Our sample is based on IPO data from the Thomson Financial SDC database. We exclude unit offers, closed-end funds, REITs, financial institutions (firms with two-digit SIC codes ranging from 60 to 63 and 67), ADRs of companies already listed in their home countries, limited partnerships, and leveraged buyouts. Moreover, we exclude seasoned equity offerings and IPOs with an offering price below $5 because firm valuations in such cases are problematic. These sample selection criteria are consistent with previous studies by Ritter (1991) and Krigman et al. (1999). Our final sample consists of 2,391 firms completing an initial public offering between January 1996 and December 2002.

High-tech firms are identified following the classification methods in Loughran and Ritter (2004) and Cliff and Denis (2004).[3] Forecasted earnings data are obtained from the I/B/E/S database. Underwriter quality is based on Loughran and Ritter (2004): the rankings are between 1.1 (low) and 9.1 (high) with integer increments. In addition, we calculate a company's age as the difference in years between its founding date and its IPO date. We hand-fill gaps in SDC's coverage of company founding dates, and manually check all firms that according to the SDC database were zero to three years old at the time of their IPO, because Loughran and Ritter (2004) note that the SDC database frequently reports the most recent incorporation date rather

[3] Loughran and Ritter (2004) and Cliff and Denis (2004) categorize firms with the following SIC codes as tech firms: 2833, 2834, 2835, 2836, 3571, 3572, 3575, 3577, 3578, 3661, 3663, 3669, 3674, 3812, 3823, 3825, 3826, 3827, 3829, 3841, 3845, 4812, 4813, 4899, 7370, 7371, 7372, 7373, 7374, 7375, 7377, 7378, and 7379.

than the founding date.[4] In addition, to ensure the accuracy of our sample, we check all potential outliers for consistency.

First-day trading prices are from the Center for Research in Securities Prices (CRSP). Two hundred and twenty-six sample firms are not covered in CRSP, thus we use the prices reported in SDC and verify them against news sources and the share price database on bigcharts.com. Financials are collected from Compustat and are based on fiscal year data before the issue. We use that information to compute sales/gross costs, accruals/total assets, and the firm's book to market ratio. Gross costs are defined as sales (Compustat data item 12) minus costs of goods sold (Compustat data item 41). Accruals/total assets is the ratio of accruals to total assets based on the first annual statement after the firm goes public, in which accruals are computed as Income Before Extraordinary Items (Compustat annual data item 123) minus Cash Flows from Operations (item 308 minus item 124). The book-to-market ratio is the ratio of the firm's book value of equity during the first fiscal year after the IPO date over the market value of equity measured at the end of the first trading day.

All IPO information including the number of shares offered, the offer price and the initial pricing range are collected from Securities and Exchange Commission (SEC) filings made available through the EDGAR database and from SDC. Since Ljungqvist and Wilhelm (2003) document that there are significant errors in the SDC variables for venture-backing and shares outstanding pre- and post-IPO, we hand-collect these variables as well. Finally, the SDC database provides little information on ownership structure and there are significant errors in the SDC's data as it relates to aggregate insider equity holdings pre- and post-IPO. Thus, we hand-collect data on CEO and insider ownership and directed share programs from prospectuses. As

[4] A detailed discussion of some of the errors in the SDC database can be found on Alexander Ljungqvist's website at http://pages.stern.nyu.edu/~aljungqvist.htm.

EDGAR provides prospectuses only for IPOs issued after May 1996, we search for the prospectuses of IPOs issued between January and April 1996 either by requesting such information directly from the firms or by collecting them from the Disclosure Global Access database.

2.1 Firm characteristics

Table I, Panel A, provides descriptive statistics on the firm characteristics of all IPO firms in our sample. High-tech companies accounted for less than half of the total annual IPO volume during the years 1996 to 1998 as well as in 2001 and 2002. In comparison, during the hot IPO market in 1999 and 2000, high-tech firms made up around two-thirds of total IPO volume. Profitability measured by net income after taxes in the most recent 12-month period before the IPO shows a clear declining trend from 1996 to 2000 but increases after 2000. Many accounting figures in our dataset are right-skewed, thus we focus our discussion on medians. The median company between 1996 and 1998 was modestly profitable with net income between $110,000 and $1,140,000. In 1999 and 2000, however, the median company had negative earnings between -$7.51 million and -$10.38 million and was again moderately profitable in 2001 and 2002. The fraction of issuing firms with negative or zero earnings rose from 53.24 percent of the sample in 1996 to about 80 percent in 1999 and 2000. After the hot IPO market, the fraction of issuing firms with negative or zero earnings decreased to about 40 percent in 2001 and 2002. When we consider revenue figures for our sample firms, it is apparent that they are heavily right-skewed. The skewness can be explained by the fact that a number of well-established businesses went public during our sample period including, for example, Lucent Technologies in 1996, Hertz in 1997, Fox Entertainment Group in 1998, United Parcel Service in

1999, AT&T Wireless in 2000, Kraft Foods in 2001, and Seagate Technology in 2002 (see also Ljungqvist and Wilhelm, 2003.) Therefore, we again focus our attention on medians when considering revenues. These fell sharply during our sample period, from $25.53 million in 1996 to $11.61 million in 2000 but then increased to $26.12 million in 2002. The median debt to asset ratio declined from 11.25 percent in 1996 to 2.98 percent in 2000 but then increased to 4.23 percent in 2001 and 25.74 percent in 2002.

[Please insert Table I about here]

As for firm age, we observe that the mean age was between 14 and 18 years in 1996 through 1998, as compared to 9 to 10 years in 1999 and 2000, but then increased to 13 and 14 years in 2001 and 2002. The median firm age follows a similar pattern. Overall, there is a noticeable trend that toward the end of the 1990s, relatively younger firms with weaker earnings and lower revenues went public. However, in 2001 and 2002, after the end of the hot IPO market, the characteristics of IPO firms roughly restored to their 1996-1998 levels.

2.2 Transaction characteristics

Panel B of Table I shows IPO transaction details during our sample period. Mean gross proceeds nearly quadrupled over the period from $57.49 million in 1996 to $201.88 million in 2002.[5] Medians remained relatively stable, between $33.6 and $37.5 million, for the period from 1996 to 1998, but then jumped to $95 and $104.85 million in 2001 and 2002, respectively. The

[5] In our subsequent discussion, we also use the term "expected gross proceeds" because they are computed as the number of shares offered multiplied by the expected offer price, where the expected offer price is the midpoint of the indicative price range included in the issuer's amended S-1 filing (or the original S-1 filing if no amendment was filed).

period from 1996 to 2000 showed a sharp increase in average underpricing and a right-skewed underpricing distribution with extreme positive outliers increasing in both frequency and size. On the other hand, these patterns reduced in magnitude and frequency during 2001 and 2002.

Across the entire sample, 1,028 of the 2,391 IPOs were backed by venture capitalists (VCs) or private equity funds. We refer to these collectively as VC-backed IPOs. From 1996 to 1998, VC-backed IPOs accounted for less than half of all issues. In contrast, 57.62 percent of issuing firms were VC-backed in 1999, and 65.3 percent in 2000. In 2001 and 2002, the fraction of VC-backed IPOs declined to approximately 48 percent and 40 percent, respectively. The mean underwriter ranking for the firms in our sample increased from 7 in 1996 to 8.3 in 2000, but then decreased to 6.9 in 2002. Interestingly, the median IPO firm hired a top-ranked investment bank (with a rank of 9.1) from 1999 to 2000 but then the median rank decreased to 8.1 in 2001 and 2002.

Ljungqvist and Wilhelm (2003) provide evidence that directed share programs (DSPs) or so-called "friends and family programs" that provide family, friends, employees, suppliers, and VCs the opportunity to purchase IPO shares at the offer price contributed to the high level of underpricing during the dot-com bubble. We collect information on DSPs for our sample firms from prospectuses and find that there are more high-tech firms that offer DSPs than non-high-tech firms. Overall, 23.9% of IPO firms offered DSPs in 1996. The proportion increased to 29.1% in 1997, 43.5% in 1998, 77.3% in 1999, and 93.8% in 2000. After the dot-com bubble, it decreased to 65.2% in 2001 and 58.4% in 2002.

2.3 Changes in pre-IPO insider ownership

The SEC requires that IPO firms disclose the ownership percentage of any persons or parties that own an equity share larger than five percent of the total number of shares outstanding in their prospectus. These parties typically include executive officers and directors.[6] Moreover, most firms disclose the percentage of ownership by executive officers and directors as a group, which the financial literature frequently refers to as the "insiders" of the firm. We follow this definition and exclude parties that do not serve on the firm's board or as part of its management team from this group. Furthermore, we follow Ljungqvist and Wilhelm's (2003) definition of "insiders" by excluding employees with stock ownership programs, junior participants in syndicated venture capital funding rounds, or corporate investors holding only small stakes. Table I, Panel B, reports the mean and median percentage of pre-IPO ownership across our sample. When measured over the entire sample period, the average (median) pre-IPO insider ownership is about 60.9 (64.7) percent. Interestingly, the variable displays an almost perfectly monotonically decreasing pattern, declining from 64.5 (67.2) percent in 1996 to 51.8 (54.2) percent in 2002. The CEO, on average, owns 21.8 percent of pre-IPO shares outstanding, which is comparable to the levels documented by Baker and Gompers (1999). There is a monotonic decline of average (median) CEO ownership from 24.9 (10.5) percent in 1996 to 9.8 (4.6) percent in 2002. Also noteworthy is that the pre-IPO ownership by CEOs and insiders is lower for high-tech IPOs than for non-high-tech IPOs.

3. Insider ownership and IPO underpricing

Leland and Pyle (1977) argue that insider ownership can be a signal of firm quality. As an insider is supposed to know the true value of his company, his willingness to hold more shares

[6] Beneficial ownership includes options that can be exercised within 60 days of the issuance. When firms issue dual class shares, we calculate the percentage of ownership as the fraction of cash flow rights instead of control rights that a person holds.

of his company indicates his confidence in the future prospect of the firm. As a consequence, a higher percentage of insider ownership implies that the firm is of higher quality.

For an IPO firm, the degree of IPO underpricing is likely to depend on its level of pre-IPO insider ownership. The higher the pre-IPO percentage of insider ownership, the higher the cost imposed on insiders from reducing the firm value (Jensen and Meckling, 1976). Entrepreneurs will suffer substantial economic losses if the firm's future performance is poor. Thus, in the belief that entrepreneurs with high ownership stakes must be confident about business prospects, investors will be prepared to subscribe to the new issue.

Empirical support for the retained insider ownership model is mixed. Using US data, Downes and Heinkel (1982) find support for the model. Research on Canadian IPOs has found evidence both in favor of the retained insider ownership model (Clarkson et al., 1991) and against it (Krinsky and Rotenberg, 1989). How and Low (1993) report Australian results consistent with the predictions of Leland and Pyle whereas a Korean study by Kim et al. (1994) finds no support for the model.

Allen and Faulhaber (1989), Grinblatt and Hwang (1989) and Welch (1989) model a separating equilibrium where high quality firms have high underpricing and pre-IPO insider ownership. They explain that good quality firms are willing to underprice their IPOs because they expect to raise more money after the IPO. In contrast, low-quality firms do not expect to access the capital markets for further rounds of financing; therefore, they are not willing to underprice but rather take the money from their IPO and "run." An implication of this separating equilibrium is the positive relation between underpricing and post-IPO market valuation. Moreover, underpricing is positively related to the probability of issuing SEOs and the size of SEOs.

In contrast to the prior literature in this area, we recognize that an issuer's insider ownership and IPO underpricing are simultaneously determined. The insiders of the firm first choose how many shares they want to hold (measured as fractional ownership) and to what extent they want the shares to be underpriced, then the market infers the true value and the risk of the firm after observing these signals. To correct for the simultaneity problem, we adopt a two-stage least squares (2SLS) approach to derive unbiased estimates of the relationship between insider ownership and IPO underpricing.

3.1 Underpricing is a function of pre-IPO insider ownership

A number of studies examine how pre-IPO insider ownership is related to underpricing. Ljungqvist and Wilhelm (2003) document that the astronomical IPO underpricing levels during 1999 and 2000 can be accounted for by a decline in pre-IPO insider ownership. They find that these changes in ownership help undermine the incentives of those most directly involved in bargaining over the offer price in a structural model of underpricing. Therefore, underpricing is larger when pre-IPO insider ownership stakes are smaller and more fragmented. Hughes (1986) develops a bivariate model that explains the substitution effects of different signals based on their relative marginal costs and benefits. Under this model, firms that have high pre-IPO insider ownership tend to have lower underpricing because of their lower level of information asymmetry.

Recent papers have proposed a link between underpricing and the resulting *(post-IPO)* ownership structure of the firm. Brennan and Franks (1997) argue that the firm's management values control; to retain control, management underprices new shares to create excess demand and oversubscription, which allow issuers to ration and allocate IPO shares to many small

investors. As a result, underpricing increases costs to blockholders reducing their motives to monitor firms. Brennan and Franks study the UK IPO market and find that firms with greater underpricing have fewer outside blockholders even years after the IPO. Smart and Zutter (2003) analyze firms that go public with dual class shares. The dual class structure is often used to keep control in the hands of the founders or controlling family while raising money through shares that have restricted voting rights. With no worries about retaining control, the firms have no need to underprice according to Brennan and Franks' theory. Smart and Zutter find that dual class firms are indeed less underpriced than other IPOs.

Conversely, Stoughton and Zechner (1998) claim that issuers underprice IPOs to entice blockholders to take a position in their firms. They argue that because the interests of shareholders and managers are not perfectly coinciding, shareholders are suspicious of managers taking their companies public. Thus, by underpricing their companies' shares, managers can attract large shareholders to invest in the firm. The underpricing is needed to encourage these shareholders to invest their resources to produce information about the firm and to monitor it.

Field and Sheehan (2003) examine these two different theories empirically and find that the link between underpricing and ownership is weak. Most firms have insider ownership before the IPO and retain it afterwards. They find no relationship between underpricing and retained insider ownership.

In this paper, we divide IPO firms into high-tech and non-high-tech IPOs to investigate whether the interrelationship between underpricing and pre-IPO insider ownership is different across these two different IPO groups. High-tech firms differ from non-high-tech firms in several ways. First, high-tech firms typically have fewer tangible assets but carry significant intangible assets in the form of patents and other intellectual property. As a result, the costs of financial

distress tend to be significantly higher for high-tech firms as compared to non-high-tech firms. Second, operating cash flows of high-tech firms tend to be more volatile making it difficult to meet interest and principal repayment obligations. Third, high-tech firms typically do not have any profits or even have large losses in early years; hence, they tend to benefit little from the debt tax-shield, i.e. from tax savings associated with the tax deductibility of interest payments. Since the dot-com bubble, there have been many studies that examined the high level of underpricing for these firms. Kim et al. (2007) show that underpricing of non-high-tech IPOs is a negative function of pre-IPO leverage whereas underpricing of high-tech IPOs is a positive function of pre-IPO leverage. Ljungqvist and Wilhelm (2003) show that the high underpricing during the dot-com bubble can be accounted for by marked changes in pre-IPO insider ownership and insider selling behavior which reduce insider's incentive to control the level of underpricing. In terms of IPO valuation, many studies find that there are noticeable differences between the valuations of high-tech and non-high-tech firms (Bartov et al., 2002 and Guo et al., 2005).

In this study, we hypothesize that the relationship between pre-IPO insider ownership and underpricing is negative for high-tech IPOs due to the more fragmented insider ownership and the increased frequency and size of "friend and family" share allocations among these firms (Ljungqvist and Wilhelm, 2003).

The more fragmented insider ownership of high-tech IPOs and the low level of CEO ownership make insiders less motivated to negotiate for higher offer prices. As such, we hypothesize that underpricing should be higher when insiders have low pre-IPO ownership. On the other hand, when insiders have high stakes in the firm, they will have an incentive to negotiate for a high offer price and thus reduce underpricing.

For non-high-tech IPOs, we hypothesize that pre-IPO insider ownership and underpricing are positively related because the large stake of insider ownership credibly signals firm quality and the insiders' commitment to the firm. According to the signaling theory (Allen and Faulhaber, 1989, Grinblatt and Hwang, 1989, and Welch, 1989), high insider ownership implies that insiders are confident about the future prospects of the firm. Insiders convey this signal to the market by underpricing.

At the same time, we argue that pre-IPO insider ownership is not as good a signal of firm quality for high-tech firms as it is for non-high-tech firms. First, high-tech firms have a high level of information asymmetry. The IPO valuation literature shows that their value cannot be explained by traditional valuation models. As noted earlier, high-tech firms are well known for having little cash and other tangible assets. Most of their assets are intangible and frequently include patents and other intellectual property. In addition, their net income is often negative, making their value depend primarily on their expected future growth. As such, insiders of high-tech firms may not know the true value of their companies' shares during the pre-issue period. Given these uncertainties, we argue that insiders of high-tech firms who have high insider ownership are reluctant to leave money on the table at the IPO as they are unsure about whether they can gain back the foregone IPO proceeds through rising stock prices in the aftermarket lateron. Thus, we argue that standard signaling theory cannot explain the relationship between insider ownership and underpricing for high-tech firms. Rather, we hypothesize that the high insider ownership of high-tech firms motivates insiders to negotiate harder for a high offer price and consequently low underpricing.

To verify our point, we investigate whether pre-IPO insider ownership and underpricing convey different signals for high-tech and non-high-tech IPOs. An issuer has private information

about the expected value and variance of returns on the firm's assets. Due to information asymmetries between the issuer and the market, public investors may assign only an average value to a high-quality firm. Indeed, less informed, conservative investors may underestimate the asset returns and overestimate the variance of returns for high-quality firms. To convey his confidence in the future prospect of the firm, an issuer with high retained ownership underprices the IPO shares. Good quality firms can afford to do that because they expect to be compensated through future rounds of financing. Lower quality firms cannot afford to signal their quality through underpricing because they can not expect to recover the money they leave on the table at the IPO during subsequent rounds of financing. In sum, signaling models such as those by Allen and Faulhaber (1989), Grinblatt and Hwang (1989), and Welch (1989) can help explain why high quality firms distinguish themselves from low quality firms by underpricing their shares to a larger extent and by selling fewer shares (i.e., retaining more shares). High-tech firms, by nature, are more difficult to value and have higher information asymmetries reflected by higher underpricing than non-high-tech firms. Hence, we hypothesize that pre-IPO insider ownership and underpricing may not convey as good a signal of firm quality for high-tech firms as they do for non-high-tech firms. We define a high-quality firm as one with a high expected return on its assets and/or a low standard deviation on its asset returns and propose the following hypothesis:

Hypothesis 1: For non-high-tech IPOs, both the proportion of shares retained by the CEO, directors, and executive officers as a group and underpricing are positively related to the firm's one-year buy-and-hold abnormal return (BHAR) and negatively related to the standard deviation of the BHAR. For high-tech IPOs, this relation does not hold.

To test hypothesis 1, we perform the following regressions:

$$(One\text{-}Year\,Buy\text{-}and\text{-}Hold\,Abnormal Return)_n = \lambda_0 + \lambda_1 (Pre\text{-}IPO\ Insider\ Ownership)_n + \lambda_2 (Underpricing)_n + \eta_n \quad (1)$$

$$StdDev(One\text{-}Year\ Buy\text{-}and\text{-}Hold\ Abnormal\ Return)_n = \gamma_0 + \gamma_1 (Pre\text{-}IPO\ Insider\ Ownership)_n + \gamma_2 (Underpricing)_n + \omega_n \quad (2)$$

where the *one-year buy-and-hold abnormal return* (BHAR) is computed with respect to the CRSP NYSE/AMEX/NASDAQ value-weighted market index; *StdDev(one-year buy-and-hold abnormal return)* is the standard deviation of the one-year BHAR; $(Pre\text{-}IPO\ Insider\ Ownership)_n$ is defined as the aggregate pre-IPO ownership by the firm's CEO, directors, and executive officers; and $(Underpricing)_n$ is calculated as the first-day closing price over the final offer price minus one. We measure one-year buy-and-hold abnormal returns without rebalancing using daily returns from the beginning of the holding period until the end of the holding period or the delisting date, whichever is earlier. Our results are robust when examining alternative post-issue windows of six months and two years. We perform both OLS and 2SLS regressions. For 2SLS, we treat underpricing and pre-IPO insider ownership as endogenous variable by regressing underpricing on X and X_1 and regressing pre-IPO insider ownership on X and X_2 (see Section 3.2 and Equations (3) and (4) for further details).

[Please insert Table II about here]

The results presented in Table II show that λ_1 is significantly positive at the five percent level for non-high-tech IPOs (columns 1 and 3). It is weakly significant for high-tech IPOs only

in the 2SLS regression (column 7). Similarly, γ_1 is significantly negative only for non-high-tech IPOs (columns 2 and 4). Overall, the results for non-high-tech IPOs suggest that the larger the pre-IPO insider ownership, the higher the one-year BHAR and the lower the standard deviation of the one-year BHAR. In particular, a 1% increase in pre-IPO insider ownership leads to an increase of about 0.591% in a non-high-tech firm's one-year BHAR and to a decrease of about 0.147% in the standard deviation of the BHAR. Shares issued by non-high-tech firms with higher pre-IPO insider ownership are on average of higher quality. λ_2 and γ_2 are positively and negatively significant at the 10% level, respectively, for non-high-tech firms (columns 3 and 4). At the same time, they are insignificant for high-tech firms (columns 5 to 8). As such, our results support the notion that non-high-tech IPOs that have high pre-IPO insider ownership and underpricing are of higher quality.

Taken together, our results show that insiders of non-high-tech firms who have a high degree of pre-IPO insider ownership convey a signal to the market that their firms have high quality by underpricing. In contrast, since high-tech firms tend to have a high level of information asymmetry, pre-IPO insider ownership may not convey a signal of quality to the market. As such, we expect that a high level of pre-IPO insider ownership for high-tech firms provides an incentive for decision makers to control underpricing by negotiating for a higher offer price. For high-tech firms, underpricing should thus be lower when pre-IPO insider ownership is high. More formally, we propose that:

Hypothesis 2: For high-tech IPOs, the degree of IPO underpricing is a negative function of pre-IPO insider ownership whereas for non-high-tech firms the relation is positive.

3.2 Pre-IPO insider ownership is a function of expected IPO underpricing

As argued earlier, a firm that is about to go public faces a trade-off in its pricing decision. Loughran and Ritter (2004) note that the increased level of insider ownership they observe during the late 1990s may both be ***a response*** to the higher underpricing during that period as well as ***a cause*** for it. They argue that during the hot IPO market in 1999/2000 "underpricing fed on itself" (pg. 12). Following their argument, we hypothesize that high expected underpricing increases insider ownership for high-tech firms due to the following reasons. First, managers may increase their ownership stakes because they want to allocate a larger proportion of their company's shares to friends and family. This is consistent with Ljungqvist and Wilhelm (2003) who find that during the hot IPO market of 1999/2000 more IPOs adopted directed share programs which allow for such preferential share allocations. Second, Loughran and Ritter (2002) show that underpricing is high following a market rise as opposed to a market fall and explain this behavior using prospect theory, which states that issuers are willing to leave more money on the table if they think that the wealth gain on their retained shares that results from an aftermarket price increase outweighs the wealth loss they experience by leaving money on the table. Following this argument, insiders will retain high ownership stakes when they expect underpricing to be sufficiently high to offset the loss they experience from offering their firm's shares at a discount. Lastly, Stoughton and Zechner (1998) argue that underpricing is high for companies that have high benefit-to-cost ratios from monitoring. Since the benefits-to-cost ratio from monitoring is higher in high-tech firms than in non-high-tech firms, insiders of high-tech firms will increase their ownership when they expect high underpricing.

For non-high-tech firms, high expected underpricing decreases pre-IPO insider ownership due to the following reasons. First, our test in Section 3.1 shows that high underpricing conveys that the issuing firm is of good quality. If underpricing is expected to be high, insiders will not increase their ownership as it would merely replicate the good quality signal already sent. In other words, to minimize their wealth losses, they will refrain from conveying a double signal. Second, since there is typically less demand for non-high-tech IPOs than for high-tech IPOs, issuers tend to be more aggressive in negotiating a higher offer price to leave less money on the table (Loughran and Ritter, 2004). Issuers of non-high-tech firms will lower their ownership when they expect high underpricing because it will provide them with an effortless alternative to the potentially time intensive and costly negotiations they may have with underwriters for a higher offer price. This explanation is also supported by Gomes (2000), Habib and Ljungqvist (2001), and other researchers who argue that insiders retain less of their ownership when underpricing imposes costs. This is particularly true for non-high-tech firms where insiders are unlikely to believe that their wealth gains from price increases in secondary market trading will outweigh their wealth losses from money left on the table. Taken together, we propose the following hypothesis:

Hypothesis 3: The degree of pre-IPO insider ownership is a negative function of expected underpricing for non-high-tech IPOs but a positive function of expected underpricing for high-tech IPOs.

This interrelation between underpricing and pre-IPO insider ownership is captured by the following two equations.

$$Underpricing = \alpha_1 + \beta_1(Pre\text{ - }IPO\ Insider\ Ownership) + \phi_1 X + \delta_1 X_1 + \varepsilon_1 \quad (3)$$

$$Pre\text{ - }IPO\ Insider\ Ownership = \alpha_2 + \beta_2(Underpricing) + \phi_2 X + \delta_2 X_2 + \varepsilon_2 \quad (4)$$

where X is a vector of exogenous IPO characteristics that are common to both equations, i.e., they are related both to underpricing and to pre-IPO insider ownership (control variables); X_1 is a vector of exogenous IPO characteristics that are uniquely related to the amount of underpricing but not to pre-IPO insider ownership (identifying variables); and X_2 is a vector of exogenous IPO variables that are directly related to pre-IPO insider ownership but not to underpricing (identifying variables).

The objective of this system of equations is to model an IPO firm's trade-off between underpricing and pre-IPO insider ownership at the time of the IPO; as a result, all of the above explanatory variables must be measurable at the time of the IPO. Equation (3) addresses whether and how expected pre-IPO insider ownership affects a firm's underpricing. Since pre-IPO insider ownership and underpricing are expected to be interdependent, estimating this equation using an ordinary least squares (OLS) model is inappropriate. Pre-IPO shares retained are not exogenous but depend partially on the amount of underpricing. For example, based on the underpricing equation, a firm that chooses to overprice its IPO will have an especially low error term, ε_1, and it is also likely to have a high (or low) level of pre-IPO insider ownership, depending on the industry. Therefore, the error term and pre-IPO insider ownership are not independent. This contradicts the assumptions of an OLS regression and estimating these equations using OLS regressions would likely lead to biased inferences.

Equation (4) examines whether *expected* underpricing predicts pre-IPO insider ownership. Following our argument above, it is again inappropriate to estimate this equation by OLS. For example, our discussion in Section 3.1 revealed that firms with higher pre-IPO insider ownership are likely to underprice their shares. Ignoring this effect would lead to an endogeneity bias. To account for the interdependence between the amount of underpricing and pre-IPO insider ownership, we treat Equations (3) and (4) as simultaneous equations.

To estimate this system of equations, it is necessary to identify both Equations (3) and (4). To be fully identified, X_1 needs to contain at least one variable not in X_2, and vice versa. To identify Equation (3), X_1 includes the natural log of the firm's book-to-market ratio, the natural log of one plus analyst consensus growth forecasts, accruals/total assets, sales/gross costs, a high-tech dummy, firm age, and the rate of return on the market prior to the IPO. Similarly, X includes the natural log of the firm's expected gross proceeds, a venture capital dummy, and the firm's underwriter ranking.

It is widely accepted that book-to-market (B/M) ratios relate to the cross-section of stock returns. Similarly, we include analyst growth forecasts because Rajan and Servaes (1997) find that IPOs with high analyst growth expectations subsequently underperform IPOs with low growth expectations. Even though there is no evidence that they are related to the cross-section of IPO returns, it is important to control for B/M effects and analyst growth forecasts on initial returns as initial returns are related to long-run returns (see Krigman et al., 1999, and Purnanandam and Swaminathan, 2004). The accruals variable is the ratio of accruals to total

assets based on the first annual statement after the firm goes public and is considered a measure of earnings quality. Similarly, the variable Sales/gross costs controls for profitability.[7]

Furthermore, we control for industry effects by assigning firms with high-tech SIC codes a dummy variable of one and zero otherwise. Firm age is controlled for and is measured as the natural log of one plus the difference between the date of a firm's IPO and its founding date (Carter et al., 1998). Market return is a control variable that conceptually explains underpricing. Specifically, we choose the compounded market return on the CRSP NYSE/AMEX/NASDAQ value-weighted market index during the 15 days prior to the IPO as the identifying variable. Loughran and Ritter (2002) show that this variable is significantly positively related to underpricing and interpret their findings as indicating that underwriters do not entirely incorporate public information that becomes available during the registration period into the offer price. Consequently, the public information (as proxied for by the market return) contributes to underpricing. Lowry and Schwert (2004) further examine this relation, and find that the significance of market returns stems from private information that is acquired during the filing period, but is not incorporated into the offer price.

The variable ln(expected gross proceeds) is the natural log of expected gross proceeds, which is the expected offer price multiplied by the number of shares offered and is used to control for size. The expected offer price is defined as the midpoint of the indicated filing price range included in the issuer's amended S-1 filing. While Carter et al. (1998) find that long-term IPO performance is affected by underwriter reputation, Logue et al. (2002) find no evidence of a relation between underwriter reputation and investor returns over different holding periods. Moreover, Doukas and Gonenc (2005) show that underwriter reputation is not linked to post-

[7] We do not use EBITDA because most IPOs have negative EBITDA and we do not want to exclude those observations from our regression.

issue IPO performance when they control for venture capital backing. Since the relation between underpricing and underwriter ranking is still inconclusive, we include both venture capital backing and underwriter ranking as controls.

Pre-IPO insider ownership is defined as the proportion of shares held by the CEO, directors, and executive officers prior to the IPO. In Equations (3) and (4), we control for firm and offer characteristic and conjecture that common characteristics, *X*, affect both insider ownership and underpricing. Field and Sheehan (2003) point out that there is no well-developed theory of what determines ownership of the firm. Despite this lack of a widely recognized ownership theory, previous researchers have proposed and estimated various models aimed at explaining ownership structure. We follow the lead of Demsetz and Lehn (1985), Himmelberg et al. (1999), and Field and Sheehan (2003) and model pre-IPO insider ownership as a function of *X*, which, as in our underpricing equation, includes firm size as measured by ln(proceeds), a venture capital dummy, and the firm's underwriter ranking.

To identify Equation (5), X_2 includes variables that are not in the underpricing regression and proxy for agency costs, such as the ratio of property, plant, and equipment to total assets and the ratio of research and development expenditures to sales. For many firms, Compustat reports a "negligible value" code, especially for research and development expenses. We set the value to zero and then add a dummy variable that equals one when the firm's value is set to zero in order to avoid deleting these firms. As such, the structural equations to be estimated are as follows:

$$Underpricing_n = \beta_1 \sigma_2 (Pre\text{ - }IPO\ Insider\ Ownership)_n^{"} + \phi_1 X + \delta_1 X_1 + \varepsilon_1 \qquad (5)$$

$$Pre\text{ - }IPO\ \ Insider\ \ Ownership_{n} = \frac{\beta_2}{\sigma_2}(Underprici\,ng)''_{n} + \frac{\phi_2}{\sigma_2}X + \frac{\delta_2}{\sigma_2}X_2 + \frac{\varepsilon_2}{\sigma_2} \qquad (6)$$

where $\sigma_2^2 = Var(\varepsilon_2)$. The estimation method consists of two stages. In the first stage, we regress underpricing and pre-IPO insider ownership on all the exogenous variables in the system (including all variables in X, X_1, and X_2) using OLS. In the second stage, we substitute the predicted values from the first-stage estimation $(Pre-IPO\ Insider\ Ownership)''$ and $(Underpricing)''$ as explanatory variables in Equations (5) and (6) and then estimate the equations, again using OLS. While we are not able to separately estimate β_1 and β_2, we can at least test whether the two coefficients are statistically different from zero.

4. Empirical results for the relationship between pre-IPO insider ownership and underpricing

This section addresses the cross-sectional relation between underpricing and pre-IPO insider ownership. Section 4.1 discusses the regression results without controlling for the endogeneity between underpricing and pre-IPO insider ownership. Section 4.2 examines the regression results using simultaneous equations.

4.1 Regression results without controlling for simultaneity

To provide a benchmark for our simultaneous equations approach, we first present the regression results without controlling for simultaneity. Columns (9), (11), and (13) of Table III show OLS regressions of underpricing on pre-IPO insider ownership plus the control variables described in the previous section for the periods 1996-1998, 1999-2000, and 2001-2002, respectively. These OLS regressions ignore the endogeneity of pre-IPO insider ownership. These

specifications suggest that underpricing is negatively related to insider ownership for non-high-tech IPOs, yet the relationship is insignificant. For high-tech IPOs, although the coefficients are negative, only the sum of the two coefficients (pre-IPO insider ownership and its interaction term with the high-tech dummy) in the bubble period, -0.277 in column (11), is weakly significant at the 10% level.[8] At first sight, these results seem to contradict our hypothesis that underpricing is an increasing function of insider ownership for non-high-tech IPOs. Yet, as argued earlier, these OLS results are likely to be biased since pre-IPO insider ownership should be treated as an endogenous variable.

Similarly, columns (10), (12), and (14) of Table III show OLS regressions of pre-IPO insider ownership on underpricing plus the control variables described in the previous section without adjusting for the endogeneity of underpricing. These specifications suggest that underpricing is insignificantly related to insider ownership for non-high-tech IPOs. The sum of the two coefficients (underpricing and its interaction term with the high-tech dummy), 0.082 in column (12), is significant at the 10% level only during the bubble period. During that period, it appears that insiders of high-tech firms who expected high underpricing increased their pre-IPO ownership. Given the low comparatively low significance of our results and the fact that it only holds in one of the three periods tested we refrain from drawing too many conclusions from our finding. Our results also seem to contradict the hypothesis that insider ownership is a decreasing function of *expected* underpricing for non-high-tech IPOs. Due to the inherent endogeneity bias in these models, however, we hesitate to draw any inferences from them and focus our discussion on the results presented in the next section.

[Please insert Table III about here]

[8] For guidelines on how to interpret summed coefficients, please see Greene (2002).

4.2 Regression results using simultaneous equations

To properly account for the endogeneity of underpricing and pre-IPO insider ownership, Table IV re-estimates columns (9) to (14) in Table III using a simultaneous equations approach (see also Lowry and Shu, 2002). Columns (15), (17), (19), (21), (23), and (25) show the first-stage regression during the pre-bubble period in 1996-1998, the bubble period in 1999-2000, and the post bubble period in 2001-2002 where the dependent variables, pre-IPO insider ownership or underpricing, respectively, are regressed against all of the exogenous variables including the control variables X and the identifying variables X_1 and X_2 in the system of Equations (5) and (6). Columns (16), (18), (20), (22), (24), and (26) show the second-stage regressions. The explanatory variables in the two equations are similar to those in Table II, except that pre-IPO insider ownership and underpricing are now substituted by the two instruments, i.e. the fitted values from the corresponding first-stage regressions.

[Please insert Table IV about here]

Inferences on the relation between pre-IPO insider ownership and underpricing and on the control variables are based on the second-stage regressions. When examining the second-stage results for underpricing in columns (16), (20), and (24), the coefficient of pre-IPO insider ownership for non-high-tech IPOs is positively significant at the 1% level (with a t-statistic of 2.79) during the dot-com bubble period and at the 5% level (with a t-statistic of 2.08) in the 2001-2002 period. During the pre-bubble period the coefficient is also positive but insignificant. Based on the signaling hypothesis, the issuers of non-high-tech IPOs who have high ownership

convey a signal that their IPOs have high quality by underpricing them. On the other hand, the interaction terms are negative and thus the sum of the two coefficients (pre-IPO insider ownership and its interaction term with the high-tech dummy) is negative and significant at the 5% level (-0.245 with a t-statistic of -2.03) in 1996-1998 and at the 1% level (-0.284 with t-statistic of -2.76) during the bubble period, implying that insiders of high-tech IPOs, who have low ownership before the issue, have less of an incentive to come up with the right offer price, thus inducing high underpricing. The strongly negative relationship during the dot-com bubble is not surprising and can be explained by the typically fragmented and low ownership of CEOs and insiders of high-tech firms that provides them with little of an incentive to negotiate for a higher offer price. Interestingly, the result contradicts our earlier OLS results that suggested a negative (although insignificant) relationship between these variables for non-high-tech IPOs. As expected, this suggests that endogeneity indeed drives the apparent negative relation between underpricing and pre-IPO insider ownership for non-high-tech IPOs.

Most of the inferences on the control variables in the regressions on underpricing are similar to the findings in the prior literature. The negative relationship between the book-to-market ratio and underpricing likely results from the fact that first-day closing prices are used to compute both variables. There is a positive relationship between underpricing and analyst growth forecasts suggesting that higher underpricing is followed by higher growth forecasts and that these forecasts are indeed affected by aftermarket performance. Underpricing is negatively related to ln(proceeds) implying that IPOs with small size have higher underpricing. Consistent with the grandstanding hypothesis (Gompers, 1996) in which the publicity associated with high first-day returns brings future commitments of capital to venture capitalists, underpricing is significantly positively related to venture capital backing. The venture capitalists allow high

underpricing because the publicity associated with an IPO with a high first-day return offers two forms of compensating benefits in the future, one of which is the ability to raise more capital than the firm would otherwise be able to in the future and the other being the increased probability of issuing SEOs (Lee and Wahal, 2004).

Further, the coefficient for the sales/gross costs variable is positive, implying that IPOs that have high profitability also have high first-day returns. The significantly positive coefficient on the high-tech dummy is consistent with the importance of information asymmetry as a determinant of underpricing. Finally, consistent with the findings of Loughran and Ritter (2000), underpricing is significantly positively related to market returns over the 15 trading days prior to the IPO.

To examine how pre-IPO insider ownership can be explained by expected underpricing, we focus our attention on the underpricing instrument in the second-stage regression shown in model (6). The results are presented in columns (18), (22), and (26). For non-high-tech IPOs, underpricing is significantly and negatively related to pre-IPO insider ownership only in the pre-bubble period. Loughran and Ritter (2002) claim that issuers negotiate for high offer price and leave less money on the table when markets fall. Insiders of non-high-tech firms may decrease their ownership if they expect their issue to be offered during a bubble period because they already anticipate that their firm will benefit from the good quality signal associated with high underpricing. Yet, to minimize their resultant wealth loss in such a scenario, insiders are likely to decrease their ownership. Conversely, we expect the insiders of high-tech firms to increase their ownership when they expect high underpricing. Our hypothesis is weakly supported before the bubble period (note that the summed coefficient is 0.231 with a t-statistic of 1.87) but holds strongly during the bubble period (where the summed coefficient equals 0.344 with a t-statistic

of 2.79). Overall, the results suggest that insiders of high-tech IPOs who – given the extant market conditions – expect high underpricing will retain high ownership to monitor underpricing. This is consistent with Stoughton and Zechner's (1998) argument that benefit-cost ratio of monitoring underpricing for high-tech firms is higher than that for non-high-tech firms. As such, insiders of high-tech firms retain more shares when they expect high underpricing. Specifically, issuers of high-tech firms appear to be more agreeable to leaving money on the table when the market rises as was the case during the dot-com bubble. As such, our results support the earlier findings of Loughran and Ritter (2002) in that these issuers increase their ownership and display behavior that is consistent with a preference of gaining wealth by means of aftermarket price gains over avoiding the expected wealth losses associated with leaving money on the table.

Both coefficients of underpricing in the simultaneous equations model are significant compared to the OLS regressions in Table III. Due to the lack of tangible assets to be used as collateral, insiders of high-tech IPOs may value all forms of financing as long as any of them is available. Moreover, it appears that insiders like to have high ownership stakes in IPOs that have low fixed assets but high R&D and that are small and financed by venture capitalists. On the other hand, they do not take underwriter rankings into account when they decide what percentage of pre-IPO shares they want to retain.

5. Conclusions

In this paper, we investigate the signaling role of pre-IPO insider ownership and IPO underpricing. In particular, we examine whether and how this signaling effect differs between high-tech and non-high-tech IPOs. While prior studies in this area generally treat pre-IPO

insider ownership as a static variable, we control for the fact that insiders can adjust their ownership prior to the IPO and treat it as a variable that is endogenously determined together with other IPO variables. Specifically, we hypothesize that insiders decide how many shares they want to hold going into the IPO based on their expectation of IPO underpricing. Thus, underpricing is not only a function of pre-IPO insider ownership, but pre-IPO insider ownership is also a function of *expected* underpricing. To analyze the relation between underpricing and pre-IPO insider ownership, we employ a simultaneous equation framework and model both variables as being endogenously determined. Our results show that non-high-tech firms that have high pre-IPO insider ownership underprice their IPOs by a greater amount to signal to investors that their issues have good quality. In contrast, high-tech IPOs that have insiders with high ownership will be intolerant of greater underpricing. We also find that greater expected underpricing lowers a non-high-tech firm's pre-IPO insider ownership because the insider realizes that the wealth loss from leaving money on the table outweighs the wealth gains they can expect from an aftermarket price runup. In addition, high expected underpricing conveys a signal of good firm quality for non-high-tech IPOs. To minimize their wealth loss, insiders will not increase their ownership if they perceive that it will merely serve as another (duplicate) signal of firm quality. For high-tech IPOs, insiders are more acquaint to high underpricing because they likely think that their aftermarket wealth gains will more than offset their losses from money left on the table. As such, they will increase their ownership when they expect high underpricing. Overall, our hypotheses hold over the entire 1996 to 2002 sample period we use for this study. Nevertheless, the results vary when we divide our sample period into three separate periods that include IPO firms that went public prior to, during, and after the 1999/2000 bubble period. We

humbly accept that we cannot conclude with confidence that insider ownership and underpricing are interrelated. They ***may*** be interrelated and therefore a 2SLS regression ***may*** be appropriate.

Furthermore, our study just provides another finding that complimentarily explains the difference of underpricing between high-tech and non-high-tech IPOs. The extant literature seems to support the deliberate underpricing by investment bankers and investment fad theories. Our explanation of underpricing is complimentary rather than mutually exclusive to the extant underpricing literature. In addition, it is beyond the scope of our study to determine whether insiders have a superior forecasting ability that allows them to predict the underpricing of their shares. Our study does not imply that insiders can forecast underpricing accurately but that insiders' ***expectation*** of underpricing, which may be right or wrong, can affect the level of their pre-IPO ownership.[9] Although insiders may not have any forecasting abilities, they seem to have an information advantage; as such, the sale of their shares may imply that they opportunistically sell their overpriced shares (Ritter, 1991, Loughran and Ritter, 1995, and Brau et al., 2007). Finally, we cannot conclude that insiders can control the level of underpricing only by the number of shares they own. Rather, we argue that their ownership can ***partially*** affect the level of underpricing. Future research in this area can further explore the relationships we observed during other periods and for other industries.

[9] We thank the referee for raising these points.

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Table I
Descriptive Statistics

This table presents descriptive statistics for our sample. In Panel A, we characterize the firms in our sample with respect to industry, accounting performance and age. In Panel B, we provide information based on the IPO transaction details of each firm. High-tech companies are identified following Loughran and Ritter (2004) and Cliff and Denis (2004) and include firms with the following SIC codes: 2833, 2834, 2835, 2836 (drugs), 3571, 3572, 3575, 3577, 3578 (computer hardware), 3661, 3663, 3669 (communications equipment), 3674 (electronics), 3812 (navigation equipment), 3823, 3825, 3826, 3827, 3829 (measuring and controlling devices), 4812, 4813, 4899 (communication services), and 7370, 7371, 7372, 7373, 7374, 7375, 7377, 7378, 7379 (software). Accounting data are from Compustat and prospectuses and are based on fiscal year data prior to the IPO. Age is calculated as the number of years between the founding date and the IPO date. Expected gross proceeds are computed as the number of shares offered multiplied by the expected offer price. Underpricing is calculated as the first-day closing price over the final offer price minus one. VC backing information is from IPO prospectuses and includes backing by either venture capitalists or private equity (middle-market, buy-out, merchant banking) funds. Investment bank rankings are based on the Carter and Manaster (1990) and Carter, Dark and Singh (1998) reputation rankings as revised by Loughran and Ritter (2004) and range from 1.1 (worst) to 9.1 (best). Pre-IPO insider ownership is defined as pre-IPO ownership by the firm's CEO, directors, and executive officers. The SEC requires that IPO firms disclose the ownership percentage of any persons or parties that own an equity share larger than five percent of total shares outstanding in the prospectus. These parties include executive officers and directors. Most firms disclose the percentage of ownership by executive officers and directors as a group referred to as the "insiders" of the firm. We follow this definition and exclude parties that are not in the board or management team from this group.

Panel A: Firm Characteristics		**1996-2002**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Number of IPOs in the sample		2,391	686	484	269	453	366	73	60
Percentage of high-tech IPOs		49.83	47.31	27.95	45.35	65.34	71.58	38.36	40.00
Net income after taxes ($m)	Mean	-6.31	-0.38	-3.48	0.04	-12.24	-19.87	-3.46	-1.23
	Median	-2.32	0.29	1.14	0.11	-10.38	-7.51	0.15	0.82
Fraction (%) with EPS $\leq$ 0		57.92	53.24	39.96	41.94	78.92	81.75	40.55	45.21
Revenue ($m)	Mean	174.94	133.41	154.74	159.19	261.43	181.59	203.68	154.81
	Median	22.36	25.53	36.08	20.95	12.74	11.61	24.97	26.12
Age	Mean	12.27	14.61	16.08	17.52	8.89	9.66	13.01	14.25
	Median	6.11	8.32	8.50	9.15	4.27	6.04	7.58	9.16

Table I (Continued)

Panel B: Transaction Characteristics		1996-2002	1996	1997	1998	1999	2000	2001	2002
Expected gross proceeds ($m)	Mean	98.17	57.49	60.22	105.00	112.50	139.02	327.91	201.88
	Median	45.50	33.60	33.06	37.50	56.00	69.41	95.04	104.85
Underpricing (%)	Mean	34.49	16.81	13.33	23.67	72.46	58.95	20.47	7.76
	Median	13.20	10.00	7.50	9.14	37.50	28.67	11.03	8.45
Fraction (%) of firms with VC backing		42.99	37.90	26.86	29.37	57.62	65.30	47.95	40.00
Investment bank ranking	Mean	7.48	7.03	7.04	7.29	8.05	8.27	7.79	6.93
	Median	8.10	8.10	8.10	8.10	9.10	9.10	8.10	8.10
CEO ownership of high-tech firms (%)	Mean	15.64	18.52	21.13	17.44	15.87	9.64	8.18	6.72
	Median	7.01	10.33	9.84	7.43	4.17	5.24	4.75	2.83
CEO ownership of non-high-tech firms (%)	Mean	25.68	30.66	31.84	31.52	26.23	15.61	12.57	11.93
	Median	10.97	11.85	14.63	15.61	10.39	7.47	6.14	5.28
Pre-IPO insider ownership of high-tech firms (%)	Mean	56.14	58.59	60.27	58.76	57.31	50.63	45.74	42.52
	Median	58.19	60.34	62.75	56.43	59.18	55.25	48.34	39.79
Pre-IPO insider ownership of non-high-tech firms (%)	Mean	65.68	69.91	64.48	64.43	67.16	61.24	56.68	58.04
	Median	69.76	73.54	70.33	72.57	71.38	63.49	58.16	63.15
Fraction (%) of firms offering directed share programs (DSPs)		50.14	23.98	29.12	43.57	77.34	93.86	65.21	58.43
Fraction (%) of DSP-offering firms that are high-tech		65.10	70.47	39.09	52.54	72.02	74.48	41.48	43.32
Fraction (%) of high-tech firms offering directed share programs (DSPs)		65.04	35.69	40.72	50.49	85.28	97.63	70.57	63.45
Fraction (%) of non high-tech firms offering directed share programs (DSPs)		46.95	13.40	24.63	37.87	62.41	84.26	61.98	55.14

Table II
Firm Quality, Pre-IPO Insider Ownership, and Underpricing

We present OLS and two-stage least squares (2SLS) regression results for our sample of 2,391 IPOs between 1996 and 2002. The dependent variable is firm quality as proxied for by the one-year buy-and-hold abnormal return of the IPO with respect to the NYSE/AMEX/NASDAQ value-weighted market index (Model 1) and the standard deviation of the buy-and-hold abnormal returns (Model 2). Pre-IPO insider ownership and underpricing in 2SLS regressions are estimators from the following first-stage regressions, respectively.

$$\begin{aligned} &Pre\text{-}IPO\ \ Insider\ \ Ownership_n = \alpha_0 + \alpha_1 \ln(Expected\ \ Gross\ \ Proceeds)_n \\ &+ \alpha_2 (Venture\ \ Capital\ \ Dummy)_n + \alpha_3 (Underwrite r\ \ Ranking)_n + \alpha_4 (PP\ \&\ E / Total\ \ Assets)_n \\ &+ \alpha_5 (PP\ \&\ E\ \ per\ Total\ \ Assets\ \ Dummy)_n + \alpha_6 (R\ \&\ D / Sales)_n \\ &+ \alpha_7 (R\ \&\ D\ \ per\ \ Sales\ \ Dummy)_n + \varepsilon_n \end{aligned}$$

$$\begin{aligned} &Underpricing_n = \beta_1 + \beta_2 \ln(Book\text{-}to\text{-}Market\,Ratio)_n + \beta_3 \ln(1 + Analyst\,Consensus\,Growth)_n \\ &+ \beta_4 (Accruals / Total\ Assets)_n + \beta_5 \ln(Expected\,Gross\,Proceeds)_n \\ &+ \beta_6 (Venture\,Capital\,Dummy)_n + \beta_7 (Sales / Gross\,Costs)_n + \beta_8 (High\text{-}Tech\,Dummy)_n \\ &+ \beta_9 (Firm\,Age)_n + \beta_{10} (Underwriter\,Ranking)_n + \beta_{11} (Market\,Return)_n + \mu_n \end{aligned}$$

where pre-IPO insider ownership is defined as pre-IPO CEO, director, and executive officer ownership. Analyst consensus growth is measured as the forecasted annual growth over the next five years or one year, whichever is available. Analyst growth rates are available only after the firm goes public. Accruals/total assets is the ratio of accruals to total assets based on the first annual statement after the firm goes public. Sales/gross costs is the ratio of sales to gross costs where gross costs are sales minus EBITDA. Firm age is the IPO year minus the founding year. Market returns are the compounded market returns in the 15 days prior to the IPO. PP&E is net property, plant, and equipment. R&D represents research and development expenses. The PP&E/total asset dummy and the R&D/total asset dummy are set to one when PP&E and R&D are set to zero because Compustat records a "negligible" value. Other variables are defined in Table I. Unless otherwise noted, accounting variables are based on fiscal year data prior to the IPO from Compustat while growth rates are from I/B/E/S. Standard errors are adjusted for time clustering by assuming that observations are independent for companies at different points in time, but not necessarily for companies that go public in the same month. Thus, they are more conservative than White (1980) standard errors. For each regressor, we provide the coefficient estimate with the corresponding t-statistic in brackets below. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively, assuming normality and independence.

	Non-high-tech				High-tech			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)
Independent variables	One-year BHAR	Standard deviation of BHAR	One-year BHAR	Standard deviation of BHAR	One-year BHAR	Standard deviation of BHAR	One-year BHAR	Standard deviation of BHAR
	-OLS-	-OLS-	-2SLS-	-2SLS-	-OLS-	-OLS-	-2SLS-	-2SLS-
Constant	-0.389***	0.161*	-0.526***	0.278***	-0.383***	0.640***	-0.411***	0.286***
	(-3.63)	(4.91)	(-3.76)	(2.08)	(-3.16)	(5.30)	(-3.90)	(3.24)
Pre-IPO insider ownership	0.591**	-0.147**	0.846**	-0.167***	0.163	-0.774	0.298*	-0.021
	(2.22)	(-2.62)	(2.21)	(-2.92)	(1.68)	(-1.48)	(1.77)	(-1.34)
Underpricing	0.175	0.124	0.276*	-0.209*	0.079	0.508	0.036	0.142
	(1.70)	(0.56)	(1.77)	(-1.83)	(1.01)	(1.16)	(1.40)	(0.87)
Adjusted R^2	37.91%	30.37%	40.35%	41.74%	20.08%	22.17%	23.95%	21.68%

Table III
Summary of Regression Results without Controlling for Simultaneity

We present ordinary least squares (OLS) regression results for underpricing in Model (3) and pre-IPO insider ownership in Model (4) based on our sample of 2,391 IPOs between 1996 and 2002. We do not yet control for potential simultaneity biases. Book-to-market ratio is the ratio of the firm's book value of equity during the first fiscal year after the IPO date over the market value of equity measured at the end of the first trading day. Analyst consensus growth is measured as the forecasted annual growth over the next five years or one year, whichever is available. Analyst growth rates are available only after the firm goes public. Accruals/total assets is the ratio of accruals to total assets based on the first annual statement after the firm goes public, in which accruals are computed as Income Before Extraordinary Items (Compustat annual data item 123) minus Cash Flows from Operations (item 308 minus item 124). Sales/gross costs is the ratio of sales over gross costs where gross costs are defined as sales (Compustat data item 12) minus costs of goods sold (Compustat data item 41). Market return is the return on the CRSP NYSE/AMEX/NASDAQ value-weighted index during a 15-day period prior to the IPO. PP&E represents net property, plant, and equipment. R&D is research and development expenses. Whenever Compustat records a "negligible" value for R&D and PP&E, we set them to zero and assign a value of one to the PP&E/total asset dummy and the R&D/total asset dummy. The pre-IPO ownership of "insiders" is based on the percentage of outstanding shares held by executive officers and directors as a group and is collected from individual firms' prospectuses. Unless otherwise noted, accounting variables are based on fiscal year data prior to the IPO from Compustat and prospectuses. Growth rates are from I/B/E/S. All other regressors are as defined in Table I. Below each coefficient, we show t-statistics in parentheses. Standard errors are adjusted for time clustering of observations, based on the assumption that observations are independent for companies at different points in time, but not necessarily for companies that go public in the same month. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% level (two-sided), respectively.

Independent Variables	(9) Model (3) Underpricing	(10) Model (4) Pre-IPO insider ownership	(11) Model (3) Underpricing	(12) Model (4) Pre-IPO insider ownership	(13) Model (3) Underpricing	(14) Model (4) Pre-IPO insider ownership
	1996-1998		1999-2000		2001-2002	
Intercept	1.227**	0.013**	1.040**	0.012***	0.973**	0.013
	(2.61)	(2.50)	(2.63)	(2.97)	(2.37)	(2.46)
Pre-IPO insider ownership	-0.055		-0.057		-0.047	
	(-0.93)		(-0.94)		(-1.15)	
Pre-IPO insider ownership * High-tech dummy	-0.116		-0.220*		-0.120	
	(-1.42)		(-1.91)		(-1.40)	
Underpricing		0.018		0.020		0.017
		(1.07)		(1.24)		(1.13)
Underpricing * High-tech dummy		0.013		0.062*		0.005
		(1.08)		(1.83)		(0.95)
ln(Book-to-market)	-0.158		-0.203		-0.148	
	(-1.72)		(-1.36)		(-1.46)	
ln(1+Analyst consensus growth)	0.157		0.148		0.246	
	(1.37)		(1.46)		(1.73)	
Accruals/Total assets	-0.423		-0.424		-0.220	
	(-1.27)		(-1.20)		(-1.15)	
ln(Expected gross proceeds)	-0.196***	0.302***	-0.205***	0.350***	-0.112**	0.303***
	(-3.15)	(3.24)	(-2.90)	(3.40)	(-2.47)	(2.79)
Venture capital dummy	-1.409***	-2.124*	-1.53**	-2.096	-1.737**	-2.465*
	(-2.81)	(-1.90)	(-2.31)	(-1.63)	(-2.14)	(-1.92)
Underwriter ranking	0.132	0.014	0.158	0.012	0.124	0.015
	(1.42)	(-1.49)	(1.20)	(1.16)	(1.19)	(1.48)
Sales/Gross costs	0.154***		0.261**		0.214**	
	(2.78)		(2.57)		(2.10)	
High-tech industry dummy	0.136*		0.338**		0.171**	
	(1.89)		(2.26)		(2.67)	

Firm age	-0.079 (-1.32)		-0.076 (-1.21)		-0.077 (-1.02)	
Market return	0.270*** (3.15)		0.270*** (2.91)		0.412** (2.40)	
PP&E/Total assets		-0.259* (-1.91)		-0.174** (-2.08)		-0.344** (-2.02)
PP&E/Total assets dummy		0.170 (1.59)		0.142 (1.50)		0.127 (1.62)
R&D/Sales		0.324* (1.83)		0.384* (1.86)		0.283** (2.46)
R&D/Sales dummy		-0.344 (-1.56)		-0.263 (-1.37)		-0.369 (-1.38)
Adjusted R^2	47.44%	37.61%	49.55%	37.66%	43.96%	41.57%

Table IV
Summary of Simultaneous Equation Regression Results

We present regression results for underpricing and pre-IPO insider ownership based on our sample of 2,391 IPOs between 1996 and 2002. These regressions test the relationship between pre-IPO insider ownership and underpricing using a simultaneous-equations approach, where pre-IPO insider ownership and underpricing are both treated as endogenous variables. Models (5.1) and (5.2) provide the first- and second-stage regressions for underpricing. The first stage is an OLS regression that has pre-IPO insider ownership as a dependent variable, and the second stage is an OLS that has underpricing as a dependent variable. The pre-IPO insider ownership instrument in Model (5.2) equals the fitted value from the first-stage regression in Model (5.1). Models (6.1) and (6.2) are the first- and second-stage regressions for pre-IPO insider ownership. The first stage is an OLS regression that has underpricing as a dependent variable, and the second stage is an OLS that has pre-IPO insider ownership as a dependent variable. The underpricing instrument in Model (6.2) equals the fitted value from the first-stage regression in Model (6.1). Unless otherwise noted, accounting variables are based on fiscal year data prior to the IPO from Compustat and prospectuses. Growth rates are from I/B/E/S. All other regressors are as defined in Tables I and II. Below each coefficient, we show t-statistics in parentheses. Standard errors are adjusted for time clustering of observations, based on the assumption that observations are independent for companies at different points in time, but not necessarily for companies that go public in the same month. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% level (two-sided), respectively.

Independent Variables	(15) Model (5.1) 1st stage: Dep. Var. = Pre-IPO insider ownership	(16) Model (5.2) 2nd stage: Dep. Var. = Underpricing	(17) Model (6.1) 1st stage: Dep. Var. = Underpricing	(18) Model (6.2) 2nd stage: Dep. Var. = Pre-IPO insider ownership	(19) Model (5.1) 1st stage: Dep. Var. = Pre-IPO insider ownership	(20) Model (5.2) 2nd stage: Dep. Var. = Underpricing	(21) Model (6.1) 1st stage: Dep. Var. = Underpricing	(22) Model (6.2) 2nd stage: Dep. Var. = Pre-IPO insider ownership	(23) Model (5.1) 1st stage: Dep. Var. = Pre-IPO insider ownership	(24) Model (5.2) 2nd stage: Dep. Var. = Underpricing	(25) Model (6.1) 1st stage: Dep. Var. = Underpricing	(26) Model (6.2) 2nd stage: Dep. Var. = Pre-IPO insider ownership
	1996-1998				1999-2000				2000-2002			
Intercept	4.306** (2.52)	1.150** (2.18)	1.0681** (2.06)	0.120 (0.83)	3.250** (2.51)	1.115** (2.42)	1.054 (1.63)	1.353** (2.16)	4.560*** (2.82)	1.123** (2.31)	1.127** (2.24)	1.523** (2.42)
Pre-IPO insider ownership instrument		0.121 (1.34)				0.244*** (2.79)				0.155** (2.08)		
Pre-IPO insider ownership instrument * High-tech dummy		-0.366** (-2.25)				-0.528*** (-4.26)				-0.205 (-1.39)		
Underpricing instrument				-0.305** (-2.58)				-0.237 (-1.61)				-0.076 (-1.01)
Underpricing instrument * High-tech dummy				0.536** (2.71)				0.583*** (4.10)				0.263 (1.20)
ln(Book-to-market)	-0.271 (-1.47)	-0.145** (-2.19)	-0.199 (-1.66)		-0.174 (-1.55)	-0.418** (-2.43)	-0.372** (-2.16)		-0.213 (-1.22)	-0.137* (-1.79)	-0.169* (-1.92)	
ln(1+Analyst consensus	0.182	0.267*	0.163*		0.164*	0.153*	0.152**		0.170	0.197	0.191*	

growth)	(1.52)	(1.82)	(1.94)		(1.85)	(1.78)	(2.13)		(1.52)	(1.71)	(1.75)	
Accruals/Total assets	-0.361* (-1.83)	-0.565 (-1.45)	-0.483 (-1.58)		-0.442** (-2.01)	-0.472 (-1.40)	-0.445 (-1.31)		-0.517 (-1.54)	-0.565 (-1.19)	-0.475* (-1.78)	
ln(Proceeds)	-0.238*** (-3.08)	-0.272** (-2.20)	-0.362** (-2.47)	-0.235*** (-3.17)	-0.212** (-2.52)	-0.289*** (-3.01)	-0.241** (-2.65)	-0.305** (-2.64)	-0.239*** (-2.82)	-0.190*** (-2.79)	-0.310** (-2.27)	-0.358*** (-3.34)
Venture capital dummy	1.522* (1.78)	1.232 (1.71)	1.132* (1.95)	1.893* (1.81)	1.491* (1.98)	1.718** (2.23)	1.533** (2.09)	0.450* (1.88)	1.638 (1.55)	1.626* (1.95)	1.559* (1.97)	1.316 (1.71)
Underwriter ranking	0.125 (0.88)	0.115 (0.46)	0.130 (1.64)	0.139 (1.07)	0.109 (0.83)	0.102 (0.48)	0.129 (1.65)	0.054 (0.18)	0.113 (0.80)	0.098 (0.35)	0.119 (1.23)	0.087 (1.22)
Sales/Gross costs	0.185*** (4.04)	0.212*** (2.88)	0.166* (1.81)		0.266*** (3.52)	0.139*** (3.21)	0.260* (1.92)		0.190*** (2.93)	0.146*** (3.52)	0.168** (2.07)	
High-tech dummy	0.181 (0.97)	0.156** (2.00)	0.182** (2.70)		0.059 (0.91)	0.156* (1.90)	0.143** (2.19)		0.083 (1.02)	0.154* (1.91)	0.165** (2.60)	
Firm age	-0.313 (-1.34)	-0.100* (-1.76)	-0.097 (-1.52)		-0.368 (-1.46)	-0.258 (-1.33)	-0.314 (-1.53)		-0.353 (-1.44)	-0.141 (-1.34)	-0.134 (-1.23)	
Market return	0.766** (2.32)	0.307* (1.98)	0.233*** (2.93)		0.324*** (2.75)	0.265* (1.93)	0.244** (2.12)		0.288*** (3.05)	0.358** (2.12)	0.560** (2.44)	
PP&E/Total assets	-0.159*** (-2.86)		-0.202 (-1.58)	-0.121** (-2.42)	-0.201*** (-2.84)		-0.157 (-1.55)	-0.191* (-1.88)	-0.161** (-2.19)		-0.202* (-1.76)	-0.255** (-2.22)
PP&E/Total assets dummy	0.522 (1.51)		0.097* (1.83)	0.144 (1.01)	0.110 (1.35)		0.105 (1.49)	0.126 (1.19)	0.105 (1.09)		0.123 (1.69)	0.112 (0.97)
R&D/Sales	0.536 (1.53)		0.409** (2.36)	0.345** (2.46)	0.289 (1.55)		0.370** (2.12)	0.367* (1.92)	0.309* (1.75)		0.781** (2.56)	0.368* (1.98)
R&D/Sales dummy	-0.220** (-2.19)		0.181 (1.36)	-0.331 (-1.50)	-0.184** (-2.18)		0.219 (1.34)	-0.338 (-1.37)	-0.193** (-2.15)		0.241 (1.35)	-0.556 (-1.63)
Adjusted R^2	43.18%	32.45%	38.66%	18.94%	49.23%	35.56%	40.21%	19.79%	42.69%	28.91%	39.10%	18.22%