The Impact of Fundamentals and Signaling on IPO Valuation

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Abstract

We investigate IPO valuation for a sample of 1,655 IPOs from three time-periods: 1986-1990, January 1997 through March 2000 (designated as the boom period), and April 2000 through December 2001 (designated as the crash period). We have four novel findings:
First, we find that firms with more negative earnings are valued more highly than are firms with less negative earnings and firms with more positive earnings are valued more highly than firms with less positive earnings. This V-shaped pattern to the relation between value and earnings suggests that inference based solely on firms with positive earnings is inaccurate, especially for the boom and crash periods.
Second, contrary to anecdotes in the financial press, we find that income of IPO firms is weighted more and sales is weighted less when valuing IPOs in the boom period compared to the late 1980's.
Third, we find that better fundamentals (lower discount rates, higher growth rates) increase the sensitivity of firm value to signaling through insider retention but not investment banker prestige. This suggests that insider retention serves a signaling role but investment banker prestige does not.
Fourth, we find that investment bankers and first-day investors assign different weights to post-IPO ownership and changes in ownership around the IPO of different classes of shareholders when pricing the IPO. Changes in the ownership retention of CEOs and VCs are more negatively associated with IPO values for tech, relative to non-tech firms. For internet firms, changes in VC ownership alone bear a significant relation with IPO values. Relative to non-tech firms, ownership retained by CEOs and VCs of both tech and internet firms is more positively associated with IPO values.

JEL classification: G1; G32; M41

Key words: Initial public offerings, equity valuation, insider ownership, investment banker prestige, new economy

1. Introduction

Valuation of initial public offerings, IPOs, occupies an important place in finance perhaps because an IPO provides public capital market participants their first opportunity to value a set of corporate assets. Valuation of IPOs is also quite relevant from an economic efficiency perspective: this is the first opportunity that managers of such (usually young) companies get to observe the price signals from the public capital markets. Such signals can either affirm or repudiate management's beliefs regarding its future growth opportunities – with obvious implications for the real economy via employment and corporate investment.

The valuation of IPOs in the late 1990s has generated significant interest in not just the financial press, but also in the popular press. Part of the reason for the popular interest in IPO valuation in the late 1990s was the public's interest in the "new *e*-conomy." In the latter half of 1990s, the stock market experienced unprecedented gains, powered by technology and internet companies (see, for example, Ofek and Richardson (2003)). These enormous price surges caused several commentators to raise questions about whether traditional valuation methods remain valid in the new *e*-conomy. McCarthy (1999) reports an example of this concern in a statement by Jerry Kennelly, Chief Financial Officer of Inktomi, "Early profitability is not the key to value in a company like this (Inktomi)." Such claims were more common in the context of IPOs. For example, Gove (2000) remarks, "But valuations are just as often based on gut feel. As one entrepreneur told me, 'It's as if everybody just settles on a number that they are comfortable with.' "

In this study, we examine whether, and to what extent, there were shifts in the valuation of IPOs in the new economy period. We consider the valuation of a sample of 1,655 IPOs during two distinct periods: 1986-1990 (hereafter, the eighties), and 1997-2001. The choice of two distinct periods for our study is motivated by our interest in understanding the IPO valuation in the new economy. This new economy has a temporal and industry characterization to it. As noted earlier, the new economy came into existence during the late 1990s. In addition, during this period, technology companies - especially those with an internet focus – were in the vanguard of this new economy. Examining IPOs during 1986-1990 allows us to construct a "traditional" IPO valuation model. The variables we include in our model are income, book value of equity, sales, R&D, industry price-to-sales ratio, insider retention and investment banker prestige ranking. We then compare this valuation model with the valuation during the new economy period, namely, 1997-2001. Given the dramatic collapse of NASDAQ and other stock markets in March 2000, some observers have argued that the market for new economy stocks, and especially IPOs, has been significantly altered after March 2000. Therefore, we break down the period 1997-2001 into two sub-periods, January 1997 through March 2000, and April 2000 through December 2001. We label these as the boom and crash periods, respectively. We also investigate valuation differences between technology and non-technology companies, and internet and non-internet companies.

Our major findings are as follows. We document shifts in the valuation of fundamentals (such as income, sales, book equity, growth opportunities, insider retention, and investment banker prestige) across time-periods. Interestingly, contrary to anecdotes in the financial press, income of IPO firms is weighted more and sales is weighted less when valuing IPOs in the boom period compared to the late eighties. We also find inter-industry differences in valuation: we document that tech firms are valued less than non-tech firms after controlling for IPO fundamentals.

We note that at the time that firms go public, there is typically a high degree of asymmetric information regarding the firms' prospects and their valuation. Leland and Pyle (1977), among others, have shown that firms (their owners and managers) can take actions to signal their quality. We examine how shifts in fundamentals over time influence variables that are thought to have signaling value. We generate comparative statics in the context of a signaling model based on Leland and Pyle (1977) that separately examines the roles of insider retention and investment banker prestige as signals. While both insider retention and greater investment banker prestige are associated with higher firm valuations, other models besides signaling models can generate these predictions. We derive two novel tests of the signaling theory. Both the insider retention signaling and investment banker prestige signaling models predict that the marginal effect of signaling on firm value is increasing in expected growth rates and decreasing in discount (equity premium) rates. To the extent that differences in industry, firm characteristics, and time periods proxy for differences in expected growth and discount rates, these differences in firm fundamentals can be used to examine the marginal effects of insider retention and investment banker prestige on firm value.

In testing the insider retention model, we find that decreases in the discount rate (as proxied by the boom period) are associated with increases in the marginal effect of insider retention on firm value. Also, increases in the discount rate (as proxied by the crash period) are associated with reductions in the marginal effect of insider retention on firm value. Furthermore, we find that increases in the expected growth rate (as proxied by industry—internet and tech—and whether or not firms have losses when they go public) are associated with increases in the marginal effect of insider retention on firm value. These results are consistent with the signaling by insider retention hypothesis.

In testing the investment banker prestige model, we find that both increases and decreases in the discount rate are associated with increases in the marginal effect of investment banker prestige on firm value. In addition, we find that increases in expected growth rates seem to have no (or even a negative) effect on the marginal benefit of investment banker prestige on firm value. Taken together, these results provide little support for investment banker prestige mattering in the way suggested by the signaling hypothesis.

Sample sizes in many prior studies are small, based on one industry, the internet, or *consider only IPOs with positive earnings* and hence limit the generalizability of their conclusions. In this paper we consider the valuation of IPOs with positive *and negative* earnings. Whereas only about twenty percent of the IPOs during 1986-1990 had negative earnings, during 1997-2001 sixty three percent of the IPOs had negative earnings. Eighty percent of the IPOs during 1999 had negative earnings, and eighty-five percent of the IPOs during 2000 had negative earnings. Additionally, and perhaps more importantly, the data suggest that IPOs with negative earnings are valued differently than IPOs with positive earnings; for example, whereas income of IPOs with positive earnings is valued positively, income of IPOs with negative earnings is valued negatively. As a result, there is a V-shaped relation between firm value and earnings. Firms with more negative earnings are valued more highly than firms with less negative earnings. Thus, inference based only on firms with positive earnings is inaccurate.

Finally, prior research has examined the ownership retention by pre-IPO shareholders only as an aggregate signal; we extend this research by studying the value implications of the ownership of different classes of shareholders, such as, CEOs, other officers and directors, venture capitalists, and other blockholders.[1] Indeed, we find that investment bankers and first-day investors assign different weights to ownership signals of different classes of shareholders when valuing IPOs.

Before turning to the rest of the paper, a few words about the scope of this paper would be in order. During the late 1990s, the popular press regularly and prominently argued that valuations of companies were irrationally high. This "irrationally high valuation" phenomenon has been compared to the tulip mania of the sixteenth century and the South Sea bubble of the seventeenth century. Our objective in this study is to understand whether and how the valuation function for IPOs has changed in recent times. Whether these shifts in the valuation function reflect rational or irrational pricing by investment bankers and / or investors is a subject that we do not explore. In light of the relatively high market valuations in the late nineties, evaluating

[1] Ljungqvist and Wilhelm (2003) provide a rich analysis of the impact of different types of shareholders on IPO *underpricing*. We view our analysis of the impact of different types of shareholders on IPO *valuation* as complementary to the analysis in Ljungqvist and Wilhelm.

market efficiency would be a very interesting topic; however, we believe that describing systematic shifts in valuation is a useful first step that should precede examinations of efficiency. [2]

The remainder of the paper is organized as follows. The next section reviews the prior literature on IPO valuation. In section three, we discuss empirical estimation issues. We discuss our sample selection procedure, data definitions, and sources in section four. Our results are presented in section five. The final section concludes with a summary.[3]

2. Extant literature on IPO valuation

Studies on IPO valuation made their first appearance in academic journals in the early 1980s and have since evolved in three stages. The earliest studies, which were published in the 1980s and early 1990s, focused on the impact of ownership retention on IPO valuations. Most of these papers were motivated as tests of the seminal Leland-Pyle model, which proposes that ownership retention by pre-IPO shareholders is a signal of future prospects. Next, a few studies in the late 1990s focused on the value relevance of accounting data for IPO firms. More recently, researchers have begun to explore the determinants of the valuation of

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[2] There are two related strands of the literature. First is the valuation of *publicly traded* firms during the late nineties and early 2000. For example, Core, Guay, and Buskirk (2003) compare the explanatory power of a valuation model in the new economy period (1995-1999) relative to earlier years for a large cross-section of publicly traded firms. They find that while the explanatory power of their model has declined in the new economy period, model coefficients have not shifted. They interpret their findings as consistent with valuations in the new economy being more uncertain and volatile around the traditional but stable valuation model. In the context of internet valuations, Schultz and Zaman (2001) and Ofek and Richardson (2003) provide evidence that in the late 1990s, the *post-IPO* valuation of internet IPOs were far greater than those of seasoned publicly traded stocks. Our focus, by contrast is to examine the valuation of IPOs *at the time* of the IPO. In addition, Demers and Lev (2001) and Keating, Lys, and Magee (2003) compare the valuation of *internet stocks* before and after March 2000. Second, recent research has made a significant contribution to our understanding of the intertemporal determinants of *IPO volume*. In a comprehensive analysis, Lowry (2003) finds that the firms' needs for equity capital and investor sentiment are important determinants of IPO volume. Pastor and Veronesi (2005) find that expected market return, expected market profitability, and prior uncertainty about the post IPO profitability are significant determinants of intertemporal shifts in IPO volume on the basis of their rigorous model and empirics. We view our analysis of the intertemporal shifts in the *IPO valuation* function as complementary to the contributions of Lowry, and Pastor and Veronesi.

internet firms, and in doing so have sometimes examined IPO valuation. We use the aforementioned chronological characterization to organize our literature review.

2.1. *Corporate ownership structure and IPO valuation*

Leland and Pyle (1977) propose a valuation model in which the current value of the firm is positively related to the percentage of equity retained by the entrepreneur taking the firm public. In their signaling model, the entrepreneur knows more about the expected cash flows of the firm than do potential investors. Further, it is costly for the entrepreneur to retain shares in the firm because by doing so he foregoes the benefits of diversifying his personal portfolio. Therefore, he will retain shares in the IPO only if he has private information that expected cash flows are likely to be high. Thus, the model implies that greater equity ownership by pre-IPO shareholders sends a credible signal of their confidence about the company's prospects to the investment banker and to potential investors, and leads to higher IPO values.

Moral hazard provides an alternative, but not mutually exclusive, explanation for this positive relation. Under this perspective, stock ownership aligns managerial incentives with those of shareholders; consequently, managers with high levels of stock ownership work harder and generate higher cash flows. New investors in the IPO anticipate this and hence high-ownership firms are valued more than low-ownership firms.

A third explanation for a positive relation between IPO values and post-IPO retention is based on the assumption of a downward-sloping demand curve for shares (see Ofek and Richardson (2001)). Under this assumption, higher retention levels imply fewer shares available for trading. Consequently, shares become a scarce commodity and their price increases.

Downes & Heinkel (1982), Ritter (1984), and Feltham, Hughes, and Simunic (1991), among others, provide evidence on the value of ownership retention. In general, consistent with

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[3] Space constraints force us to omit a discussion of the institutional aspects of going public. The interested reader may consult Arkebauer and Schultz (1994).

the theoretical predictions, these studies document a positive relation between IPO valuation and ownership retention.

2.2. Valuation of accounting data

While there have been numerous papers that have investigated the value relevance of accounting information for publicly traded stocks, there have been very few papers that have conducted a detailed study of the relevance of accounting information for IPO firms. These papers are briefly reviewed below.

Klein (1996) examines the relation between the price per share (at the offer date and at the end of the first day of trading) and various variables for a sample of 193 IPOs with *positive* pre-IPO income from the years 1980-1991. She finds that the price per share is positively related to pre-IPO earnings per share and pre-IPO book value of equity per share.[4]

Kim and Ritter (1999), hereafter KR, investigate the relation between firm-level price-earnings (PE) ratios and the industry-median PE ratios for a sample of 190 IPOs that had *positive* pre-IPO income and completed in the years 1992-1993. KR document that firm-level and industry-level PE ratios are positively related, but that the adjusted R^2 of their regression is only five percent. Their model's explanatory power improves when they consider forecast earnings for the next year instead of pre-IPO historical earnings. They conclude that industry comparables based on historical accounting information are of limited value for understanding IPO pricing.[5]

[4] Additionally, she finds that IPO prices are positively related to the percentage of shares retained by pre-IPO shareholders, investment banker prestige, and whether or not the offering was a unit offering; IPO prices are negatively related to whether or not a firm discloses a risk warning on the prospectus cover page.

[5] KR obtain pre-IPO one-year ahead earnings forecasts from Renaissance Capital, a private company. We requested Renaissance Capital for earnings forecast data for our sample firms but they declined. Additionally, even in the post-IPO period, analyst coverage for most firms begins more than one month after the offer date. For example, Rajan and Servaes (1997) document that analyst forecasts are available only for a third of their sample within one year of the offer date. More recently, Bradley, Jordan, and Ritter (2003) document that analyst forecasts are available for three-fourths of their sample one

In an insightful recent paper, Purnanandam and Swaminathan (2004), hereafter PS, compare the offer price to sales, and offer price to earnings of a sample of 2,288 IPOs during 1980-1997 IPOs that had *positive* pre-IPO income with similar valuation ratios of industry peers. Interestingly, they find using the above valuation metrics that IPOs tend to be overvalued. Also, in the cross-section, overvalued IPOs have lower profitability, higher accruals, and higher analyst growth forecasts.[6] [7]

2.3. Internet IPO valuation studies

Motivated by the popular interest in internet valuations in the late 1990s, several studies have attempted to understand the valuation of internet companies in general. Of these studies, Hand (2003) and Bartov, Mohanram, and Seethamraju (2002) alone examine valuation around the IPO date.

Hand (2003) examines a sample of 116 internet IPOs from the years 1997-1999 whose pre-income book value of equity is positive and income before non-recurring items is negative. Using a logarithmic specification, he finds that IPO valuation (based on offer price and first-day closing price) is positively and linearly related to the pre-income book value of equity, but negatively and concavely related to income before non-recurring items. Consistent with the argument that large R&D and marketing costs are intangible assets and not period expenses, he documents that offer values are increasing and concave in R&D and marketing costs. Further, IPO values are unrelated to sales and cost of good sold expenses.

Bartov, Mohanram, and Seethamraju (2002) focus on the valuation of 98 internet IPOs and 98 offer-date and size-matched non-internet IPOs that were completed during 1996-1999.

month after the offer date. However, post-IPO analysts' earnings forecasts depend on IPO valuations; this leads to endogeneity problems.

[6] Kim and Ritter (1999) and Purnanandam and Swaminathan (2004) focus on *relative* valuation of IPO firms, whereas our focus is on the IPO's total offer value. We view our work as complementary to that of Kim and Ritter, and Purnanandam and Swaminathan.

Their conclusions are based on per share regressions. For internet IPOs, they find that cash flows, sales, and sales growth are significantly related to offer prices (at the filing date and at the offer date). In contrast, earnings, book value of equity, and R&D per share do not bear a significant relation to offer prices.[8] For non-internet IPOs, offer prices are positively related to earnings, cash flow, and sales, but first-day closing prices do not bear a significant relation with any of the financial variables.

3. IPO valuation model: empirical estimation issues

3.1. Choice of dependent variable: price-earnings ratio, offer price, or total offer value?

A critical issue in the specification of an IPO valuation model is the designation of the dependent variable. Some authors, notably KR and PS, have designated the offer price or first-day closing price per share deflated by earnings per share as the dependent variable. The problem with using earnings as the divisor is that it leads to the elimination of firms with negative values of earnings, and thus reduces the generalizability of the findings. This is especially a problem for the IPOs for 1997-2001, where sixty-three percent of the IPOs have negative earnings in the year before the IPO. This criticism is also relevant to book value of equity, although to a lesser extent – forty-one percent of the 1997-2001 sample has negative pre-IPO book values of equity. We reject a third deflator, sales, because some IPO firms have no sales or extremely small values for sales. This small denominator problem induces considerable non-normality in the price-to-sales ratio. For example, for our sample, the skewness of the cross-sectional distribution of price-to-sales ratio is 26.9 and the kurtosis is 856.5.

A second candidate for the dependent variable is the offer price per share. On econometric grounds, the offer price has attractive properties in that it has a close-to-normal

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[7] In a recent paper, Houston, James, and Karceski (2005) also consider the *relative* valuation of a sample of 153 IPOs during 1996-2000.

[8] Cash flows and earnings bear an asymmetric relation with offer prices – when it is positive, it is positively related to offer prices; when it is negative, it is negatively related to prices.

distribution. For our sample, its skewness is 1.1 and its kurtosis is only 3.4. Additionally, deflation by shares outstanding is likely to reduce heteroscedasticity in regression residuals. However, we believe that it is deficient on theoretical and empirical grounds. First, investment bankers estimate total offer value first and *then* partition it somewhat arbitrarily into price per share and shares to be outstanding. Because of this problem of arbitrariness, we believe using price per share as the dependent variable reduces the researcher's ability to detect significant correlations. To illustrate one facet of this arbitrariness, consider the fact that in our sample - 191 firms (or 10.3 percent) were priced at $12 per share (the mode). The pre-IPO income for these firms ranged from -$66.4 million to $71.4 million. Obviously, for this sub-sample the offer price has very little to do with the level of pre-IPO income. A consequence of this arbitrariness is that regressions of price per share on earnings per share and other per share variables have very low R^2 (only two percent).[9] Second, since most IPOs have an offer price between $10-18, earnings-per-share will be large for IPOs with poor growth opportunities, and small for firms with good growth opportunities. Unless one can completely control for growth opportunities, there will be an omitted variable bias that will bias the coefficient on earnings-per-share towards zero.

Because it is total offer value that investment bankers estimate, we consider total offer value defined as offer price multiplied by the post-IPO shares outstanding as the dependent variable.[10] Unfortunately, total offer value is afflicted with the non-normality problem (skewness = 10.6, kurtosis = 217.4) that we observe for price-to-sales ratios, as well as with the heteroscedasticity problem. To mitigate these problems, we employ the logarithm of total offer value as the dependent variable. For our sample, log total offer value has a skewness of 0.07

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[9] Another source of arbitrariness is that offer prices tend to be integer-valued. This is in contrast to prices in the post-IPO market where prices are based on fundamentals and are hence not constrained to be integer-valued. For our sample, 80.7 percent of the IPOs had integer offer prices. Of the remaining firms, 15.3 percent had offer prices of an integer plus fifty cents.

[10] Consistent with Ljungqvist and Wilhelm (2003), the post-IPO shares outstanding excludes the shares related to the over-allotment option.

and a kurtosis of only –0.30. In Appendix A we discuss additional issues related to the use of the logarithmic transformation.

In addition to offer price-based valuation, we also model IPO valuation based on first-day closing prices. The difference between first-day closing price (market value) and the offer price can be considered as the amount by which the investment bankers underprice the IPO. However, as noted earlier, the focus of this paper is on understanding the determinants of the levels of IPO values and not those of underpricing.

3.2. Empirical determinants of IPO valuation

One of the objectives of this study is to investigate whether the IPO valuation function has shifted in the late 1990s (the new economy) relative to the 1980s. Our sample is drawn from two distinct periods: 1986-1990 and 1997-2001. Whereas the 1986-1990 period is arguably a more stable valuation regime, the 1997-2001 period was characterized by a historically unusual rise and fall in stock market valuations. Specifically, after a dramatic and prolonged rise in stock prices in the late 1990s, the NASDAQ and other stock markets collapsed in March 2000. This led some observers to argue that the market for new economy stocks, and especially IPOs, was significantly altered after March 2000. Therefore, we divide the years 1997-2001 into two sub-periods, January 1997 through March 2000, and April 2000 through December 2001. We define two dummies, BOOM and CRASH, corresponding to these two sub-periods. BOOM equals one if an IPO was conducted during January 1997 through March 2000, and zero otherwise; CRASH equals one, if an IPO was conducted during April 2000 through December 2001, and zero otherwise. The coefficients on the two dummies measure the incremental valuation associated with IPOs in the boom and crash periods relative to the 1980s.[11]

Conceptually, the value of an asset is the sum of the present value of its expected future cash flows. Estimating the expected future cash flow of most any company is non-trivial; this task is even more challenging for IPO firms given that, in general, less is known about their past performance and there is greater uncertainty about their future prospects. Instead of directly estimating future cash flows and the cost of capital to discount these cash flows, we construct proxies for the cash flows and discount rates; these proxies involve financial and non-financial variables. We discuss these proxies below.

In a seminal article, Ohlson (1995) develops a model that expresses the market value of equity as a linear function of earnings, book value of equity, and other information. Subsequently, a sizable body of empirical research (see for example, Penman (1998) and Francis and Schipper (1999)) has used this model to motivate empirical investigations of the value relevance of earnings and book value of equity. Accordingly, we include earnings and book value of equity at the end of the year before the offering date (year -1). In addition, to allow firm value to vary as a function of firm size, we include sales for year -1 in our valuation function.

The market value of a firm is positively related to its growth opportunities. Growth opportunities are especially critical for IPOs given that much, if not most, of an IPO's value is based on them. We use two proxies to measure the growth opportunities of our IPO firms: research & development (R&D) costs and the median price-to-sales ratio of recent IPOs in the same industry. Several studies in accounting and finance have used R&D as a proxy for growth opportunities (Smith and Watts (1992), Gaver and Gaver (1993), Baber, Janakiraman, and

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[11] As a robustness check, we also redefine the CRASH dummy to equal one if the IPO is from the period June 2000 through December 2001, thus excluding IPOs from the months March 2001 through May 2001 from our study. Our conclusions are unchanged under this modification.

Kang (1996)).[12] Industry price-to-sales ratios control for growth because firms from the same industry tend to have similar growth opportunities. Additionally, they also capture industry-level variation in other factors that influence valuation, such as, differences in the cost of capital.[13]

As discussed in greater detail in Appendix B, the ownership retained by pre-IPO shareholders and investment banker prestige could also be important determinants of the IPO's value.[14] Therefore, we also include these two variables on the right hand side of our valuation function.

As with our dependent variable, we apply the log transformation to all the independent variables except the boom and crash dummies, insider retention, and investment banker prestige. To retain negative values of income and book value of equity in our analysis, we use the transformation, L(.), proposed by Hand (2003):

$L(W) = \log_e(1+W)$ when $W \geq 0$ in \$millions;

$L(W) = -\log_e(1-W)$ when $W < 0$ in \$millions.

The transformation is monotone and one-to-one and ensures that L(W) is defined when W is zero or close to zero. Figure 1 illustrates this functional form for the range of values for income before R&D and extraordinary items in our sample.

In light of the above discussion, our basic econometric valuation model is (the usual error term is omitted):

$$\begin{aligned} L(OV)_i = {} & \alpha_0 + \alpha_1 BOOM_i + \alpha_2 CRASH_i + \alpha_3 L(INCBRD)_i + \alpha_4 L(BV)_i + \alpha_5 L(SALES)_i \\ & + \alpha_6 L(R\,\&\,D)_i + \alpha_7 L(INDPS)_i + \alpha_8 INSRET_i + \alpha_9 IBPREST_i \qquad (1) \end{aligned}$$

where,

OV	= Offer price time shares outstanding on completion of IPO,
BOOM	= One, if IPO is completed between January 1997 and March

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[12] With issues regarding measurement of R&D expenditures and its impact on valuation, see Bhagat and Welch (1995), Lev and Sougiannis (1996), and David, Hall, and Toole (2000).

[13] As a robustness check, we also use sales growth in year -1 as an additional proxy for growth opportunities – our conclusions are qualitatively similar.

[14] Loughran and Ritter (2003), Ljungqvist and Wilhelm (2003), Carter, Dark and Singh (1998), and Beatty and Ritter (1986) consider the relation between investment banker reputation and IPO *underpricing*. Leland and Pyle (1977) discuss the relation between insider retention and IPO valuation.

	2000, and zero otherwise,
CRASH	= One, if IPO is completed between April 2000 and December 2001, and zero otherwise,
INCBRD	= Income before extraordinary items and R&D in year –1, where year 0 is the IPO year,
BV	= Book value of equity at the end of year –1,
SALES	= Sales for year –1,
R&D	= Research and development costs in year –1,
INDPS	= Median industry price-to-sales ratio of recent IPOs,
INSRET	= Percentage of the post-IPO firm owned by pre-offering shareholders, and
IBPREST	= Investment bank prestige ranking.

Two measurement issues are worthy of clarification. First, we add back R&D when calculating INCBRD because we wish to separate the effects of profitability and investment on market values. Second, because R&D can be viewed as a stock, we also construct an R&D stock variable, assuming an amortization period of three years beginning from the year of the initial investment. Specifically, we define R&D stock as the sum of two-thirds of R&D in year –1 and one-third of R&D in year –2. Our results are qualitatively similar when we use this stock variable instead of the actual R&D in year –1.[15]

In Eq. (1), INSRET captures the aggregate post-IPO retention levels of pre-IPO shareholders. The ownership structure of IPO firms displays considerable variation. On the one extreme, we have highly concentrated structures where the management or a single blockholder holds a significant majority of the stock; on the other end, we have less concentrated ownership structures where ownership is distributed among management, venture capitalists, and other blockholders. Because each of these classes of shareholders has different information about future prospects, their ownership retention levels could differentially

[15] We also considered marketing costs as an additional variable that could influence IPO values, but did not incorporate them because of data availability considerations. Based on a random sample of five percent of the 1,655 IPOs for which we have complete data, we find that most IPO firms do not disclose separate amounts for marketing costs in their prospectuses; instead they combine marketing costs with general and administrative costs. Specifically, we examined thirty-three IPO prospectuses from 1986-1990 and fifty-seven prospectuses from 1997-2001. We find that only seven firms (21 percent) from 1986-1990 and twenty-five firms (44 percent) from 1997-2001 provide separate amounts for marketing costs.

affect offer values. Aside from informational issues, these classes of shareholders have a differential ability to impact future cash flows and, hence, IPO value. CEOs and other top managers have a greater ability through the efforts they expend on behalf of the firm to directly affect cash flows. Venture capitalists and blockholders could potentially play a monitoring role that is valued by prospective investors (Megginson and Weiss (1991), and Morsfield and Tan (2003)). Therefore, we also estimate an expanded version of Eq. (1) where we replace INSRET with eight variables.

The first four variables are post-IPO ownership of the CEO, of non-CEO managers as a group, of venture capitalists as a group, and of other five percent blockholders as a group. We predict a positive relation between these four post-IPO ownership variables and IPO value. The next four variables are changes in these ownership percentages around the time of the IPO; changes might convey incremental information not contained in levels. We define changes in percentage ownership as ownership percentage immediately before the IPO less the percentage immediately after the IPO. A larger change in percentage ownership implies a larger decrease in ownership which signals lower confidence about future prospects, and a lesser alignment of their interest with outside investors. Therefore, we predict a negative relation between change percentages and IPO value. Declines in ownership percentages at the IPO date could be caused by the issuance of new shares by the IPO firm (primary offerings) or by the sale of shares by the pre-IPO shareholders to the prospective investors (secondary offerings). We do not disentangle the impacts of these two factors on IPO valuation.

3.3. Are the fundamentals valued differently over time and across industries?

Eq. (1) assumes that model coefficients are constant inter-temporally and across the cross-section of IPOs. Next, we incorporate the insight from our IPO valuation model of Appendix B and expand our specification to allow coefficients to vary across time-periods, between technology and non-technology firms, between internet and non-internet firms, and between loss firms and non-loss firms.

To test for differences in valuation of the independent variables in Eq. (1) across time-periods, we interact BOOM and CRASH with each of the seven independent variables in that equation. These interaction terms allow us to test whether IPO fundamentals were valued differently in the boom and crash periods, relative to a more stable period –1986-1990.

Ritter and Welch (2002) document that the percentage of technology (hereafter, tech) firms increased from twenty-five percent of the IPO market in the 1980s and early 1990s to thirty-seven percent after 1995 and then to seventy-two percent during the internet bubble before returning to twenty-nine percent in 2001. To allow for the possibility that cross-sectional differences in offer values could be associated with these dramatic shifts in the proportion of tech IPOs, we include a dummy for whether or not a firm is a tech firm (TECH). Because tech firms are more R&D-intensive than are other firms, and payoffs to R&D investments are more uncertain than those from other tangible investments (Kothari, Laguerre, and Leone (2002)), we expect that earnings and sales of tech firms to be valued less than those of other firms. To allow for these slope differences, we include interactions of TECH with INCBRD, SALES, INSRET, and IBPREST. For consistency, we also include the interactions of TECH with BV, R&D, and INDPS as additional control variables.

In light of the evidence in Hand (2003) and BMS, we expect internet IPOs to be valued differently from other firms. Therefore, we include a dummy (INTERNET) that equals one if the firm is an internet firm, and zero otherwise. As with tech firms, we include interactions of INTERNET with each of the seven variables, INCBRD, BV, SALES, R&D, INDPS, INSRET, and IBPREST. Our motivation for including these interaction terms parallel those for the tech firms. We wish to point out that tech firms include internet firms.[16]

[16] The Spearman correlation between the internet and tech dummy is 0.54, suggesting that they are distinct variables. There are no internet firms during 1986-1990. There is a considerable overlap between

Hayn (1995) and Basu (1997) hypothesize and find evidence that in stock returns-earnings regressions, coefficients on negative earnings are smaller in absolute value than those on positive earnings. The intuition underlying this prediction is that losses are less likely to persist; this is either because firms that suffer losses are more likely to be liquidated or because of conservative accounting rules. Motivated by these findings, we define an indicator variable (LOSS) that equals one if income before extraordinary items is negative, zero otherwise, and include it and its interaction with INCBRD as additional explanatory variables.

Based on the above discussion, our extended model is:

$$
\begin{aligned}
\mathrm{L(OV)i} = {} & \alpha_0 + \alpha_1 \mathrm{BOOM}_i + \alpha_2 \mathrm{CRASH}_i + \alpha_3 \mathrm{L(INCBRD)}_i + \alpha_4 \mathrm{L(BV)}_i + \alpha_5 \mathrm{L(SALES)}_i \\
& + \alpha_6 \mathrm{L(R\ \&\ D)}_i + \alpha_7 \mathrm{L(INDPS)}_i + \alpha_8 \mathrm{INSRET}_i + \alpha_9 \mathrm{IBPREST}_i + \sum_{j=10}^{16} \alpha_j BOOM_j \times Z_j \\
& + \sum_{j=17}^{23} \alpha_j CRASH_j \times Z_j + \alpha_{24} TECH_j + \sum_{j=25}^{31} \alpha_j TECH_j \times Z_j + \alpha_{32} INTERNET_j \\
& + \sum_{j=33}^{39} \alpha_j INTERNET_j \times Z_j + \alpha_{40} LOSS_j + \alpha_{41} LOSS_j \times L(\,INCBRD)_j \\
& + \alpha_{42} LOSS_j \times INSRET_j
\end{aligned}
\tag{2}
$$

where TECH, INTERNET, and LOSS are respectively indicators for technology, internet, and loss firms, Z is the matrix composed of the following seven column vectors: L(INCBRD), L(BV), L(SALES), L(R&D), L(INDPS), INSRET, and IBPREST, and the × operator represents column-by-column multiplication.[17]

4. Sample and data

4.1. Sample construction

We obtain our initial sample of U.S. IPOs by non-financial companies for the years 1986-1990 ("late eighties") and 1997-2001 ("late nineties") from the Thomson Financial Securities

internet and technology firms during 1997-2001; however, not all technology firms are in the internet industry.

Data Company database (SDC). The initial sample excludes best efforts offerings, IPOs with proceeds of less than $5 million, IPOs of units of shares and warrants, spin-offs and equity carveouts, IPOs of financial companies, and IPOs by limited partnerships. After these exclusions, we are left with 699 IPOs from the late eighties and 1,381 IPOs from the late nineties.[18]

Next, we read the prospectus of each IPO firm in the initial sample to identify and eliminate IPOs that are misclassified by SDC. Misclassifications relate to our sample selection criteria.[19] There were thirty-eight such misclassifications by SDC in the late eighties sample and sixty-two such misclassifications in the late nineties sample. Additionally, for the late eighties sample, we exclude twenty-six offerings by firms that were not listed on Standard & Poor's 1997 COMPUSTAT industrial, full coverage, or research files. For the late nineties sample, we also exclude eighty-seven firms that had multiple classes of stock. Lastly, we were unable to obtain prospectuses for two firms in the late eighties sample and ten firms in the late nineties sample. Our final sample, after these exclusions, consists of 633 IPOs from the late eighties and 1,222 IPOs from the late nineties. Out of these 1,855 IPOs, only 1,655 IPOs have complete data on all the variables employed in our regressions. Specifically, 150 firms are missing data for median industry price-sales comparables, forty-nine firms began operating in the middle of year

[17] As robustness checks, we include the level of the Nasdaq composite index, and the three-week return on this index prior to the offering date as additional independent variables. Our conclusions are unchanged with the inclusion of these two variables.

[18] Some of these exclusions might cause our sample to be non-random, and thus reduce the generalizability of our results. For example, on average, firms that raise proceeds of less than $5 million are smaller than those that raise a larger amount. Of the firms that completed an IPO in the years 1986-2001 and which reported data on annual sales in SDC, firms with proceeds of less than $5 million had median offering-year sales of $3.2 million. In contrast, the median offering-year sales of the firms that raised more than $5 million was $27.9 million. Schultz (1993) presents evidence that firms that conduct IPOs of units of shares and warrants tend to be smaller and younger than those that make pure share offerings. Thus, by excluding these two classes of offerings, we tilt our sample toward offerings by larger and older firms.

[19] SDC erroneously treats a few unit offerings as pure share offerings and a few spinoffs as regular IPOs. We also discovered offerings by financial companies, offerings by foreign companies, and offerings that were not IPOs in our initial sample.

-1 and hence do not report full year of data for sales and other income statement numbers, and one firm does not have data on post-IPO ownership retention.[20]

4.2. Data definition and sources

For each firm in the late eighties sample, we either purchased a hard copy of its prospectus from Disclosure, Inc. or obtained a hard copy from our University's library. For the late nineties sample, we purchased electronic copies of prospectuses from IPO Data Systems, Inc. or obtained them from *www.sec.gov*. We read these documents and coded data on pre-offering financials, share ownership before and after the offering, and shares sold by pre-offering shareholders. Other data used in the study were obtained from several sources, including the University of Chicago's CRSP tapes, Standard & Poor's COMPUSTAT tapes, and SDC. Below, we describe our data sources and some measurement issues.

4.3. Offering data

Data on offer date and offer price are from SDC. For IPOs from 1986-1990, pre-IPO and post-IPO shares outstanding are hand-collected from prospectuses. For 1997-2001, shares outstanding were either obtained from Professor Ljungqvist at New York University or hand-collected from prospectuses. We believe that it is important to use hand-collected data for shares outstanding because Ljungqvist and Wilhelm (2003) point out that there are several errors in this variable in the SDC database.

4.4. Financial statement data

We employ four financial statement variables in our analysis: sales, income before extraordinary items, research and development expenditures (R&D), and book value of equity. For all our sample firms, we hand-collect the data for these variables from prospectuses for three years: the fiscal year before the offering date (year -1) and the two preceding years (years

[20] Compared to the firms that have complete data on all variables, the 150 firms for which we do not have data on price-sales comparables have smaller market capitalization based on offer prices, but have

-2 and -3). If a firm did not have operations for an entire year or commenced its operations in the middle of a year, we code the three income statement variables for that year as missing. We record book value of equity at the end of the year whenever a firm reports it.[21] With respect to R&D, if a firm reports a full year of financial results, but R&D is undisclosed for that year, we assume that it equals zero. To minimize the possibility of error, whenever possible, we crosschecked our data with COMPUSTAT.[22]

4.5. Stock price and return data

Consistent with recent research, CRSP, and not SDC, is our source for first-day closing prices (see for example Loughran and Ritter (2004) and Ljungqvist and Wilhelm (2003)). We also obtain pre-offering market returns and one-year post-IPO firm returns from CRSP. Pre-offering market return are buy-and-hold returns on the value-weighted market portfolio compounded over the 15 trading days (three weeks) before the offer date. Post-IPO returns are also buy-and-hold returns, compounded daily over the 260 trading days beginning from the day after the date of the offering. Returns are truncated at the earlier of the delisting date or the last day of the one-year horizon. We use post-IPO returns as an instrumental variable for post-IPO ownership retention when we account for the latter's endogeneity using three-stage least squares.

4.6. Industry price-to-sales comparables

We follow Kim and Ritter (1999), with a few modifications, in our calculation of industry median price-to-sales comparables. The median is based on the price-to-sales ratios of five or fewer most recent IPOs that have the same three-digit SIC code as the IPO firm. Recent IPOs are identified from the two year period before the IPO date. For the 1,655 firms in our final sample, the distribution of the number of comparable firms used to compute the median is as

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higher return on assets in year -1. Therefore, our conclusions are subject to this sample selection issue.

[21] We use pre-issue book value of equity. Given the large inflow of capital from the IPO issuance, the post-issue book value would lead to a mechanical relation between offer value and book value.

follows: 5 comparable firms each for 1,287 sample firms; 4 comparable firms: 65 sample firms; 3 comparable firms: 75 sample firms; 2 comparable firms: 105 sample firms; 1 comparable firm: 123 sample firms.[23] To compute the price-to-sales ratio of the peer IPOs, we obtain their stock prices on the day before the sample IPOs' offer dates (from CRSP) and divide it by the peer IPOs' annual sales per share (from COMPUSTAT) for the most recent fiscal year before that date.

4.7. Ownership retention

Consistent with Schultz and Zaman (2001) we measure aggregate post-IPO ownership retention of pre-IPO shareholders, INSRET, as (shares outstanding after offering – primary and secondary shares issued) / shares outstanding after offering. Data on primary and secondary shares are from SDC.

As discussed earlier, we also examine the impact of ownership retention of different types of pre-offering shareholders. We consider post-IPO ownership percentages and changes in these percentages around the IPO date for four classes of shareholders: the CEO, officers and directors excluding the CEO, venture capitalists (VCs), and other five percent blockholders. Because SDC provides little information on ownership structure, we hand-collect this data from prospectuses. When calculating percentage ownership of non-CEO officers and directors, we exclude shares that outside directors own on behalf of VC firms and other five-percent blockholders. Outside directors refer to board members who are not employees of the firm.

VC firms were identified by comparing the names of the pre-offering shareholders disclosed in the prospectus with the list of VC firms in the annual volumes of the Pratt's Guide to Venture Capital Sources (1984-2001). To measure VC ownership, we aggregate the ownership percentages held by each VC firm that held at least five percent of the pre-offering outstanding

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[22] COMPUSTAT reports data for year -1 for a high proportion of the firms in our sample. Data on year –2 and year –3, however, are always missing on COMPUSTAT.

[23] Our conclusions are unchanged when we exclude the 228 firms for which we have two or less than two IPOs from the same three-digit SIC code in the two years before the offer date.

shares. All shareholders who own at least five percent of the pre-IPO firm and who are not VCs or employees are classified as other blockholders. As we do for VCs, we aggregate blockholder ownership percentages to arrive at a single number for this category. When calculating ownership percentages of VCs or blockholders, we include shares held by outside directors as their representatives on the board. When a firm has no VC (blockholder) ownership, VC (blockholder) percentage ownership equals zero.

The above detailed ownership data was collected by hand. While the data collection process was time consuming, we think this data allows us to make a unique contribution to the IPO valuation and corporate governance literature: the impact of different types of shareholders on IPO valuation. Post-IPO ownership and change in ownership convey different signals about the confidence of the particular shareholder class in the firm's future prospects. Also, the four classes of shareholders have a differential ability through their effort and/or monitoring to impact future cash flows and, hence, IPO value.

4.8. Investment banker prestige

We use the investment banker prestige rankings employed by Loughran and Ritter (2004). Data on the rankings were provided by Professor Ritter at the University of Florida. Rankings range from 1.1 to 9.1, with the most prestigious investment bankers being assigned the rank of 9.1.

4.9. Industry classification

Firms were classified into internet and non-internet firms based on data provided by Professor Ritter (see Appendix 4 of Loughran and Ritter (2004)). We adopt the SIC scheme employed by Loughran and Ritter (2004) to classify IPOs into technology and non-technology IPOs. Consistent with Loughran and Ritter (2004) and Ljungqvist and Wilhelm (2003), technology firms include internet firms.

5. Results

5.1. Data description

Table 1 presents year-by-year means (Panel A) and medians (Panel B) of the offer value, first-day closing value (hereafter, market value), and the main independent variables used in our regressions. Because medians are robust to outliers, our discussion focuses on trends in medians. The IPO frequencies reported in the second column of the Table are based on the final sample of 1,855 IPOs. However, the median and means for some years/variables are based on smaller sample sizes because of missing data. In Panel C, we report frequencies of loss firms, technology firms, and internet firms.

Median offer values and market values of IPOs have increased considerably in recent years relative to the years 1986-1990. The median offer value was $77.6 million in 1990. By 1998, this number had increased to $147.5 million before shooting up to $291.7 million in 1999 and $377.9 million in 2000; it then falls to $321.5 million in 2001. The median price-to-sales multiple ranged from 1.7 to 3.0 between 1986 and 1990, increased to 3.9 in 1998 before jumping to 31.7 in 1999 and 39.2 in 2000. In 2001, however, it had dropped back to 3.0.

The dramatic increase in absolute and relative valuations in the years 1997-2000 and their subsequent fall in 2001 could be related to changes in financial and other characteristics of firms conducting IPOs in these two periods. We provide some informal descriptive evidence in this regard in Table 1. Median sales ranged from $26.1 million to $33.6 million in the 1980s; however, from 1997 through 2000 it has a declining trend, with an especially sharp drop in 1999. In 2001, the trend reverses with median sales increasing to a relatively large $68 million. Median income before extraordinary items in the 1980s was quite small and ranged from $1.1 million to $1.9 million. Beginning from 1998, as was widely noted in the financial press, median income turned negative. The second column of Panel C provides related data on the frequency of firms reporting losses in the year before they went public. In the late 1980s, this number was stable and ranged from 19.6 to 22.1 percent. By 1997, this number had increased to 42.7 percent and continued to increase until 2000 when nearly eighty-five percent of the completed IPOs were unprofitable. In 2001, however, this number came down to about sixty-nine percent.

Returning to Panel B, until 1998, median R&D is zero or very close to zero. This reflects the fact that, until that year, significant fractions of the sample were non-tech firms that spent little or no funds on R&D. As the third column in Panel C indicates, in the 1980s, the frequency of tech firms completing IPOs was 20.4 to 33.8 percent. This number increased in 1997 and 1998 before becoming greater than fifty percent in both 1999 and 2000. Consequently, median R&D turns positive in the latter two years. In 2001, the percentage of tech firms drops to thirty-five percent and median R&D once again equals zero.[24] The higher R&D levels for 1999 and 2000 provide a partial explanation for the increased lack of profitability of the IPOs from those years.

The years 1998-2000 were the heady years of the internet. This is reflected in the high percentage of internet IPOs in those years, which is reported in the last column in Panel C. In 2001, however, the fraction of IPOs that were internet-related dropped to 5.9 percent.

Turning to the last two columns of Table 1, median insider retention was stable in the 1980s, ranging from seventy to seventy-five percent; in 1999, however, it increased moderately from seventy-three to eighty-one percent. After increasing slightly to eighty-two percent in 2000, it drops to seventy-six percent in 2001. Investment banker prestige rankings are above eight throughout the sample period, and are at their highest during 1999-2001.

Overall, Table 1 documents significant increases in IPO valuations in the 1990s, especially in 1999 and 2000, followed by a drop in 2001. These valuation shifts were accompanied by significant changes in the profile of issuing firms as measured by profitability,

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[24] The Spearman correlation between the TECH dummy and R&D is 0.51, suggesting these two variables are distinct.

sales, R&D spending, industry growth opportunities, insider retention, and investment banker prestige ranking. In our regression analysis, we examine the extent to which these factors explain the changes in valuations.

5.2. Basic model of IPO valuation

Table 2 reports two sets of regressions. In the second and third column we report our baseline regression where the dependent variable is either the logarithm of offer value or first day closing value and the independent variables are the two dummy variables for the boom and crash periods. By estimating these regressions we quantify the differences in average valuations between the boom and crash periods on the one hand and the eighties on the other. In the last two columns we report regressions where the baseline model is augmented with our seven basic independent variables – income, book value of equity, sales, R&D, industry price-to-sales comparables, insider retention, and investment banker prestige. The data consists of 1,655 observations pooled across all the years in our sample.

The results of our baseline regressions verify the well-known fact that the average IPO valuations in the boom period were significantly higher than those in the 1980s. This finding holds for both offer values and first-day closing values.[25]

Turning to the results on the other independent variables: The results indicate that income is reliably and negatively related to offer values. At first glance, this result seems counter-intuitive because income is a proxy for future cash flows. However, Hand (2003) provides evidence that suggests that when internet firms lose money and these losses reflect strategic expenditures such as investment in intangibles, higher losses imply greater future cash flows from such investments in intangible assets. Hence, for these firms, greater losses are

[25] In non-tabulated regressions, we include the internet dummy variable to the four regressions in Table 2. The internet dummy variable is significantly positive in the four regressions implying that (without adjusting for different valuations of IPO fundamentals) internet IPOs were valued significantly higher than

valued more positively. Therefore, the negative coefficient on income might be caused by loss firms. In subsequent analysis, we expand our specification to include a dummy variable for loss firms (LOSS) and an interaction term between LOSS and income.

Table 2 indicates that sales of IPO firms are positively valued by the underwriter (and first-day investors) – a one percent increase in sales is associated with a 0.15 percent (0.14 percent) increase in offer values (first-day closing values). Book value of equity has no bearing on IPO valuation; this is in contrast to the prior findings for publicly traded firms. R&D is positively related to offer values. The coefficient estimate on R&D implies that a one percent increase in R&D is associated with a 0.07 (0.11) percent increase in offer values (first-day closing values). The other growth proxy, price-to-sales comparable, also has the expected positive coefficient; further, its coefficient size is similar to that of R&D. IPO values are positively related to the two non-financial variables, investment banker prestige and insider retention as well. Interestingly, the coefficients on these two variables are larger in terms of economic significance compared to those of the financial variables such as income and R&D. For example, the coefficient on investment banking prestige implies that a one percent increase in it is associated with a 1.90 percent increase in offer value. Similarly, the coefficient on insider retention implies that a one percent increase in post-IPO retention by pre-IPO shareholders is associated with an increase in offer value of 2.65 percent.[26]

Overall, the results suggest that IPO firm characteristics explain a portion of the differences in average values between the late 1990s and the late 1980s. Additionally, the results suggest that non-financial variables such as investment banker prestige and insider ownership are economically more important in determining IPO value than are financial variables such as income, sales, and R&D.

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non-internet IPOs. This is consistent with Ofek and Richardson (2003) who focus on seasoned internet valuations.

5.3. Are insider retention and investment banker prestige endogenous?

Thus far, we have assumed in our empirical work that insider retention is exogenous to firm valuation. Obviously, models based on Leland and Pyle (1977) such as ours in Appendix B suggest that this is not the case. Further, Ritter (1984) points out that a firm that plans to raise a fixed amount of capital in the IPO would have higher levels of ownership retention as firm valuation increases.[27] This implies that both firm valuation and post-IPO ownership levels are jointly determined endogenous variables, and endogeneity may be a concern even separate from the signaling hypothesis. The same possibility exists for investment banker prestige. If more prestigious investment banks choose higher-valued firms to take public, then IPO valuation and investment banker prestige are also jointly determined endogenous variables even separate from the issue of signaling.

To account for the endogeneity of insider retention and investment banker prestige, we use the three-stage least squares (3SLS) procedure. We estimate a system of three simultaneous equations. The dependent variables for the three equations are offer value, insider retention, and investment banker prestige.

We model insider retention as a function of logarithm of R&D, logarithm of price-to-sales comparables, one-year post-IPO returns, as well as the logarithm of offer value. R&D and price-to-sales comparables are publicly observable proxies for growth opportunities and are likely to be positively related to insider retention; this is because insiders will retain more shares if their firm has good prospects. We include post-IPO returns to capture insiders' private

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[26] For the investment banker prestige variable, to obtain 1.90 percent, we multiply its regression coefficient, 0.24 by its sample mean, 7.92. Similarly for the insider retention variable, to obtain 2.65 percent, we multiply its regression coefficient of 3.58 by its sample mean, 0.741.

[27] This possibility, labeled "the wealth effect" by Ritter, depends on the assumption that the firm is raising fixed proceeds for investment. If firms wish to maximize proceeds, then this effect may no longer exist. Additionally, a higher offer price may increase the likelihood of pre-offering shareholders selling more shares at the IPO leading to lower post-IPO retention. However, these selling incentives are somewhat mitigated by the tax impact of capital gains related to selling shares.

information about expected future performance; additionally, its inclusion ensures model identification. We model investment banker prestige as a function of logarithm of offer value and two instrumental variables – the percentage change in CEO's ownership and the CEO's post-IPO ownership.[28] [29]

In Table 3, we report coefficient estimates for the three equations. While we tabulate results using offer values, we obtain similar results when we use first-day closing values. Overall, the results indicate that accounting for endogeneity of insider retention and investment banker prestige does not alter our conclusions. In particular, in the offer value regression, both insider retention and investment banker prestige remain positively and significantly related to IPO value. The only impact of using three-stage least squares is that offer value is no longer significantly related to R&D costs.

5.4. Differences in IPO valuation across time-periods and industries

The regressions in the last two columns in Table 2 constrain the coefficients of the financial and non-financial variables to be constant across time-periods and industries. Next, we relax this constraint and examine the impact of allowing the slope coefficients on our independent variables to vary across time periods, for tech and internet firms, and for loss firms. We are particularly interested in whether differences in IPO valuations between the late 1980s and late 1990s as represented by the coefficients on the boom and crash dummies, are influenced by this model modification. Before we turn to our findings, we wish to clarify one aspect of our regression that will aid interpretation. We include dummy variables for the boom and crash periods, tech and internet firms, and for loss firms. Therefore, the base group

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[28] The Spearman rank correlation of insider retention and percentage change in CEO ownership is -0.39; hence these variables are distinct. Also, the Spearman rank correlation of insider retention and post-IPO CEO ownership is -0.10.

[29] We use the Stock and Yogo (2004) weak instruments test; the F-statistics suggest that our instruments are appropriate. We also conduct the Hansen-Sargan test; this test compares the second stage residuals

consists of firms whose IPO was completed in the years 1986-1990 which are profitable and which belong to non-tech industries. The coefficients on our seven basic independent variables (income, book equity, sales, R&D, industry comparables, investment banking prestige, and insider retention) are interpreted accordingly.

Table 4 contains the main findings of the paper.[30] Because the results for offer value and first-day market values are similar for most variables, we discuss results for offer value alone and highlight only the differences for the two dependent variables.

Our first set of findings relates to inter-period shifts in the valuation of firm characteristics. Overall, for profitable non-tech firms in the late 1980s, with the exception of book value of equity, all the independent variables in our valuation model were valued positively. In the boom period relative to the late 1980s, while income and investment banker prestige were valued more, sales and R&D were valued less. Of these findings, the most surprising result is that income was valued more because this is contrary to assertions in the financial press that income became a less important value indicator in the new *e*-conomy period. In the crash period, while income, book value of equity, and investment banker prestige were valued more, sales and industry comparables were valued less.

Second, we expect the valuation of income and sales to be different for tech firms and internet firms. Income and sales of tech and internet firms are likely to be valued less because the prospects of these firms are more uncertain. Consistent with our expectation, sales for tech and internet firms are valued less; however the coefficient on the interaction between the dummy for tech firms and sales is not statistically significant. Contrary to our expectation, tech firms' income is valued higher than that of non-tech firms; however, income of internet firms is not valued any differently than non-internet firms.

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with the first stage instruments – see Davidson and MacKinnon (2004). The chi-square statistics indicate that our instruments and the system of equations are well-identified.

[30] Appendix Table 1 provides a more compact version of the regression results noted in Table 4.

Our third set of findings relates to loss firms. Income for profitable non-tech firms was valued positively in the late 1980s (coefficient = 0.21). Recall that in the earlier regressions in Table 2, the coefficient on income was negative. The reversal in the sign of the coefficient can be attributed to the inclusion of the interaction between the dummy for loss firms and income. The coefficient on the interaction between the dummy for loss firms and income is -0.49, consistent with the findings of Hand (2003) and BMS for internet firms. Thus, for loss firms, increases in income are actually penalized by investment bankers and first-day investors. We believe that this is attributable to the possibility that losses reflect strategic expenditures such as marketing costs and other investments in intangible assets. While the income of loss firms is valued asymmetrically, loss firms themselves are valued similarly to profitable firms - the coefficient on the dummy for loss firms is not statistically significant (t statistic = -0.4). Lastly, as predicted, insider retention of loss firms is valued more than that of profitable firms (coefficient = 0.60); however, this coefficient is only marginally significant. We interpret this evidence that investment bankers and first-day investors perceive retention as a more credible signal of management confidence about firm prospects when the firm is losing money.

5.5. Quantile regressions

The most popular estimation method in valuation research is ordinary least squares (OLS). The use of OLS is justified by the fact that it is best linear unbiased estimate of linear model coefficients and the overall best estimate when regression residuals are normally distributed. Additionally, if residuals are normally distributed we have convenient access to a distribution theory for inference. Unfortunately, with valuation models, normality is the exception rather than the rule, with residuals in general containing outliers generated by fat-tailed distributions. In this situation, OLS may not be the most efficient estimator in the class of linear and non-linear estimators.

Therefore, to confirm that the OLS results in Table 4 are not being driven by outliers, we employ the semi-parametric method of quantile regression (or robust regression), which was first proposed by Koenker and Bassett (1978). As Koenker and Hallock (2001) note, "there is a rapidly expanding empirical quantile regression literature in economics that, taken as a whole, makes a persuasive case for the value beyond models for the conditional mean (OLS)." The finance literature has incorporated robust regression techniques; for example, see Aggarwal and Samwick (1999), and Chan and Lakonishok (1992). In contrast to OLS, which estimates a conditional mean, robust regressions provide an estimate of the median value of the dependent variable conditional on the set of explanatory variables. Coefficient estimates are not sensitive to outliers. Importantly, when errors are non-normal, quantile regression estimators may be more efficient than least squares estimates.[31]

The robust regression results are in Table 5. Note that the robust "t-ratios" are much larger than the OLS t-statistics for both specifications. This is because the robust regressions give less weight to outliers and hence result in standard errors which are smaller than those of OLS.[32] A second point about the robust estimates is that the distribution of t-ratios is not well specified. Therefore, to evaluate the statistical significance of the robust t-ratios we apply the Chebyshev inequality; this inequality applies to any standard random variable with finite variance, regardless of its distributional properties and sample size (see Mood, Graybill, and Boes (1974)). It implies that, under the null hypothesis, the probability that the absolute value of any random variable (in our case, the t-ratio) is greater than or equal to some constant k is less than or equal to $1/k^2$. For example, the probability of observing a t-ratio of 10 or more is less than $1/(10)^2$, or 0.01.

[31] Koenker and D'Orey (1987), Buchinsky (1998), and Koenker and Hallock (2001) provide surveys of the methodological issues related to and applications of the quantile regression approach.

[32] Because OLS standard errors are based on sum of the *squared* residuals, outliers "inflate" the standard error estimates.

5.6. Evidence on signaling value of insider retention and investment banker prestige

We next see what light our empirical results can shed on two signaling models of IPO valuation. In Appendix B we derive several testable comparative statics from a variant of the Leland and Pyle (1977) model. We consider two separate and distinct types of signals—signaling through insider retention and signaling through investment banker prestige. We show how changes in exogenous drivers of firm valuation (discount rates and growth expectations) influence firms' signaling schedules. In particular, we test the following four hypotheses which are unique to the signaling explanations.

H_1: Increases in discount rates should decrease the responsiveness of firm value to insider retention (the signaling schedule should flatten).

H_2: Increases in growth rates should increase the responsiveness of firm value to insider retention (the signaling schedule should become steeper).

H_3: Increases in discount rates should decrease the responsiveness of firm value to investment banker prestige (the signaling schedule should flatten).

H_4: Increases in growth rates should increase the responsiveness of firm value to investment banker prestige (the signaling schedule should become steeper).

An interpretation of the boom and crash periods is that they actually signify periods of high and low growth expectations, respectively. In order to separate the discount rate effects from the growth rate effects, two other variables that are frequently used to proxy for growth expectations are included in the specifications: R&D and the price-to-sales comparable. In all specifications, the coefficients on R&D and the price-to-sales comparable are positive and significant, as predicted by the model. Of course, to the extent that these variables capture growth expectations, we should expect that any model would generate the implication that value is increasing in growth expectations.

A direct implication of the signaling with insider retention hypothesis is that firm value will be increasing in insider retention. This result shows up quite strongly in all specifications.

However, note that there is an alternative interpretation in which the reason why firms with higher valuations have higher insider ownership or retention is not signaling, it is that they have to sell less of the firm in order to finance the projects they want to undertake, precisely because they are good firms (see Ritter (1984)). In other words, the chain of causality is good firms have higher valuations, so they do not need to sell as much equity in order to fund a given set of projects.

In order to differentiate between signaling explanations and non-signaling explanations (that is, the firm is a good firm, but this is not private information), we next consider additional predictions of the signaling through insider retention hypothesis. If things that should affect the value of signaling (for example, discount rates as proxied by boom and crash) change the effect (coefficient) of insider retention on firm value, then it is more likely that a signaling-based explanation is valid.[33]

Hypothesis 1 above from the insider retention signaling model implies that the coefficient on Boom*insider retention should be positive and the coefficient on Crash*insider retention should be negative. In Table 4, the coefficients are insignificant. However, in Table 5, after controlling for outliers, the coefficients are positive and significant on Boom*insider retention and negative and significant on Crash*insider retention, consistent with the signaling through insider retention model. These results suggest that the marginal value of signaling is higher when access to capital is greater, as proxied for by lower equity risk premia. Note as well that the negative coefficient on Crash*insider retention does not imply that firm value is lower when insider retention is higher. In the offer value specification from Table 5, the coefficient for insider retention is 1.99 and for Crash*insider retention is –0.53. Thus, the overall effect of insider retention during the crash period is still positive at 1.99 – 0.53 = 1.46. What is important is that the slope has been reduced, that is, the marginal effect of insider retention on firm value is lower in the crash period, as predicted by the model.

Another prediction of this model is that the marginal effect of growth expectations on firm value decreases when discount rates (or equity risk premia) increase. It is worth noting that any rational model of valuation would predict this as well, so we do not consider this to be a separate test of the signaling models. The prediction is that the coefficients on Boom*L(R&D) and Boom*L(Price-to-sales comparable) should be positive and the coefficient on Crash*L(R&D) and Crash*L(Price-to-sales comparable) should be negative, where R&D and the price-to-sales comparable are the proxies for growth expectations. In Table 4, the coefficients on Boom*L(R&D) are negative and significant, contrary to our prediction, while the coefficients on Boom*L(Price-to-sales comparable) are insignificant. The coefficients on Crash*L(R&D) are insignificant, while the coefficients on Crash*L(Price-to-sales comparable) are negative and significant, consistent with the prediction. In Table 5, the coefficients on Boom*L(R&D) are negative and significant, contrary to our prediction, while the coefficients on Boom*L(Price-to-sales comparable) are positive and significant, consistent with the prediction. The coefficients on Crash*L(R&D) and Crash*L(Price-to-sales comparable) are negative and significant, consistent with the prediction. The evidence for this prediction is somewhat mixed, although always consistent for the price-to-sales comparable as the proxy for growth.

Hypothesis 2 from the insider retention signaling model is that the marginal effect of insider retention on firm value increases when growth expectations increase. While the previous proxies for growth (which empirically are somewhat problematic) are not interacted with the insider retention variable, two industry dummy variables (tech and internet) and a firm characteristic variable (loss) that can proxy for growth expectations are interacted with insider retention. The two industry dummies, tech and internet, are sectors that are associated with very high growth expectations, especially in the period 1997 to 2001. Firms with losses when going public are almost by definition growth firms. In Table 4, the coefficients on Tech*insider retention and Internet*insider retention are positive and significant, consistent with this

[33] See Fama and French (1989) and Azariadas and Smith (1998).

prediction. The coefficients on Loss*insider retention are positive, but insignificant. In Table 5, the coefficients on all three interactions are positive and significant, consistent with the theory. Overall, the evidence seems reasonably consistent with hypothesis 2.

We next consider the implications of the signaling via investment banker prestige model, some of which overlap with the model in which firms signal with insider retention. The common predictions are that firm value decreases in the discount rate, increases with growth expectations, and that the marginal effect of the growth rate on firm value decreases with the discount rate. Indeed, any valuation model should generate these predictions. Instead, we focus on the unique predictions associated with investment banker prestige.

The first prediction is that firm value is increasing in investment banker prestige. This result is found in all specifications. However, this result itself is not sufficient to establish that signaling with investment banker prestige is what is happening. For example, it could be that high quality investment banks choose high value companies to take public (see, for example, Fernando, Gatchev, and Spindt (2005)).   Again, other comparative statics are needed to sort through competing possibilities.

A more direct test of the investment banker prestige-signaling model is that the marginal value of hiring a more prestigious investment banker decreases when the discount rate increases, which is hypothesis 3. Using boom to signify a decrease in the equity risk premium and crash to signify an increase in the equity risk premium, this model predicts that the coefficients on Boom*investment banker prestige should be positive and the coefficients on Crash*investment banker prestige should be negative. In Tables 4 and 5, the coefficients on Boom*investment banker prestige are positive and significant, consistent with the prediction. However, the coefficients on Crash*investment banker prestige are also positive and significant, contrary to the model's predictions.

Hypothesis 4 from the investment banker prestige signaling model is that the marginal value of hiring a more prestigious investment banker increases when growth expectations increase. As we did before, if we use tech, internet, and loss to signify firms with high growth expectations, we can examine the interactions of these growth proxies with investment banker prestige. In Table 4, the coefficients on Tech*investment banker prestige and Loss*investment banker prestige are insignificant. The coefficients on Internet*investment banker prestige are negative and significant, contrary to the model's predictions. In Table 5, the coefficients on Tech*investment banker prestige and Internet*investment banker prestige are negative and significant, again contrary to the predictions of the model. However, the coefficients on Loss*investment banker prestige are now positive and significant, consistent with the model's predictions.

Overall, the evidence does not provide strong support for the signaling through investment banker prestige model (hypotheses 3 and 4). While not all predictions are borne out, the evidence seems more consistent with the signaling through insider retention model (hypotheses 1 and 2). In particular, the evidence shows that increases in growth rates and decreases in discount rates are associated with an increase in the marginal effect of insider retention on firm value. These predictions and associated results are unique to the insider retention signaling model. More generally, these results suggest that changes in fundamentals elicit endogenous changes in the responsiveness of firm value to signaling. Note that our 3SLS results from Table 3 are also consistent with this view.

5.7. Do different owners convey different signals to prospective investors?

We next delve deeper into the relation between insider retention and IPO valuation. The regressions in Tables 2 through 5 use the level of ownership retention of *all* pre-IPO shareholders as an explanatory variable. We now examine whether levels of and changes in ownership percentages around the IPO date of different classes of shareholders convey different information to prospective investors.

We begin with some descriptive statistics related to detailed ownership structure. Table 6 presents the year-by-year means and medians of the ownership percentages before and after the IPO and the change in ownership percentages of four classes of shareholders: CEOs, officers and directors as a group (not including the CEO), VCs, and other blockholders who are neither officers nor directors nor VCs. In general, for all variables, means are larger than medians suggesting the presence of large positive observations that are skewing the distributions to the right. Apart from this difference, means and medians convey the same picture in terms of trends and therefore we discuss means alone. Numbers for ownership changes are positive because we defined change as percentage ownership before the offering less percentage ownership after the offering.

Mean pre-IPO CEO ownership is quite large in 1986 (34.6 percent). It declines in 1987 and 1988, exhibits no discernible trend until 1998, and then declines again in 1999 and 2000 before increasing in 2001. The trend in mean pre-IPO ownership of officers and directors other than the CEO mirrors that of the CEO. Mean changes in ownership percentages at the IPO date for these two classes of shareholders are relatively large in 1986 and 1987 and become progressively smaller over the sample period, reflecting the fact that pre-IPO ownership levels have become smaller to start with.

Whereas mean management ownership exhibits a general decline over our sample period, the ownership percentages of VCs and other blockholders display an increasing trend over the sample period. Mean pre-IPO VC ownership was 7.8 percent in 1986; by 2001, this number has increased to 21.7 percent. Similarly, other blockholders held 13.2 percent, on average, in 1986; at the end of our sample period, in 2001, this percentage has increased to 31.7 percent. Consistent with the increasing levels in ownership, ownership changes for these two groups are also larger in the more recent years.

Overall, Table 6 documents a significant shift in the ownership profile of IPO firms in the years 1997-2001 relative to the late 1980s. In recent years, VCs and other blockholders own a greater fraction of the IPO firm both before and after the IPO; in contrast, management owns less of the firm.

In Table 7, we report valuation regressions to assess the significance of the detailed ownership variables. In general, the coefficients on the financial and growth variables are similar to those reported in Table 2 – the inclusion of the detailed ownership variables instead of aggregate ownership retention does not change our inferences.[34] As expected, we find that post-IPO ownership by each of the four classes of shareholders is positively related to offer values. The coefficients related to VCs and blockholders are the largest, followed by that of CEOs and then by that of other officers and directors. These coefficients are economically meaningful. An increase in the VCs' post-IPO ownership by one percent is related to a .16 percent increase in the IPO valuation. An increase in the CEO's post-IPO ownership by one percent is related to a .12 percent increase in the IPO valuation.[35]

Additionally, as expected, changes in ownership retention for each of the four shareholder categories are negatively associated with offer values implying that smaller changes in retention percentages lead to higher values.[36] The estimated coefficients are statistically and economically significant. A decrease in the change in CEO's ownership retention by one percent is related to a .15 percent increase in the IPO valuation. A decrease in the change in VCs' ownership retention by one percent is related to a .14 percent increase in the IPO valuation.[37]

[34] The only change is that book value of equity gains statistical significance in this expanded specification. However, the size of its coefficient remains economically small.

[35] For the VCs' (CEO's) post-IPO ownership variable, to obtain .16 (.12) percent we multiply its regression coefficient, 1.26 (.76), by its sample mean, .125 (.163).

[36] Recall that change in ownership is defined as percentage ownership before the offering less percentage ownership after the offering.

[37] For the CEO's (VCs') change in ownership retention variable, to obtain .15 (.14) percent we multiply its regression coefficient, -2.33 (-3.45), by its sample mean, .065 (.041).

Overall, we conclude that investment bankers and first-day investors assign different weights to post-IPO ownership and changes in ownership around the IPO of different classes of shareholders when pricing the IPO.[38]

We also explore inter-industry differences in the valuation of detailed ownership variables. Given the greater interest in prior academic research on the impact of ownership of CEOs and VCs on firm value, we focus on the valuation differences related to the levels of post-IPO ownership, and changes in ownership for these two classes of shareholders. These results are contained in Table 8. The results indicate that changes in the ownership retention of CEOs and VCs are more negatively associated with IPO values for tech, relative to non-tech firms. For internet firms, changes in VC ownership alone bear a significant relation with IPO values, compared to other firms. Relative to non-tech firms, ownership retained by CEOs and VCs of both tech and internet firms is more positively associated with IPO values.

7. Summary and conclusions

In this paper, we make four contributions to the literature on IPO valuation. First, the extant literature on IPO valuation considers only IPOs with positive earnings and this limits the generalizability of their conclusions. In this paper we consider the valuation of IPOs with positive *and negative* earnings. Whereas only about twenty percent of the IPOs during 1986-1990 had negative earnings, during 1997-2001 IPOs with negative earnings increased by more than three-fold to sixty-three percent. Eighty percent of the IPOs during 1999 had negative earnings, and eighty-five percent of the IPOs during 2000 had negative earnings. Additionally, and perhaps more importantly, the data suggest that IPOs with negative earnings are valued differently than IPOs with positive earnings; for example, whereas income of IPOs with positive earnings is valued positively, income of IPOs with negative earnings is valued negatively.

[38] The F-statistic to test the equality of the coefficients of the changes in ownership levels across the four classes of shareholders, rejects the null. Similarly, the F-statistic to test the equality of the coefficients of

Second, we document shifts in the valuation of fundamentals across time-periods. Most interestingly, contrary to anecdotes in the financial press, income of IPO firms is weighted more and sales is weighted less when valuing IPOs in the boom period (1997 to March 2000) compared to the late eighties.

Third, we test comparative statics from a model of IPO valuation based on Leland and Pyle (1977), focusing on the signaling role of insider retention and investment banker prestige. Both the insider retention signaling and investment banker prestige signaling models predict that the marginal effect of signaling on firm value is increasing in expected growth rates and decreasing in discount (equity premium) rates. To the extent that differences in industry, firm characteristics, and time periods proxy for differences in expected growth and discount rates, these differences in firm fundamentals can be used to examine the marginal effects of insider retention and investment banker prestige on firm value.

In testing the insider retention model, we find that decreases in the discount rate (as proxied by the boom period) are associated with increases in the marginal effect of insider retention on firm value and increases in the discount rate (as proxied by the crash period) are associated with reductions in the marginal effect of insider retention on firm value. We also find that increases in the expected growth rate (as proxied by industry—internet and tech—and whether or not firms have losses when they go public) are associated with increases in the marginal effect of insider retention on firm value. Further tests show that these effects are present for different categories of insiders (for example, CEOs, other officers and directors, venture capitalists, and other blockholders), but that the magnitudes of these effects vary as the sizes of the holdings vary by category and over time. Overall, these results support the signaling by insider retention hypothesis.

In testing the investment banker prestige model, we find that both increases and decreases in the discount rate are associated with increases in the marginal effect of investment

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the post-IPO ownership levels across the four classes of shareholders, rejects the null.

banker prestige on firm value. This result is inconsistent with the signaling hypothesis. One interpretation of this result is that investment banker prestige has simply become more important over time for exogenous reasons and this effect swamps changes in the discount rate. In addition, we find that increases in expected growth rates seem to have no (or even a negative) effect on the marginal benefit of investment banker prestige on firm value. Taken together, these results provide little support for investment banker prestige mattering in the way suggested by the signaling hypothesis. If anything, these results are more consistent with the idea that high quality investment banks choose to take public high value firms, and that this effect has become more pronounced over time.

Fourth, we find that investment bankers and first-day investors assign different weights to post-IPO ownership and changes in ownership around the IPO of different classes of shareholders when pricing the IPO. Our results indicate that changes in the ownership retention of CEOs and VCs are more negatively associated with IPO values for tech, relative to non-tech firms. For internet firms, changes in VC ownership alone bear a significant relation with IPO values, compared to other firms. Relative to non-tech firms, ownership retained by CEOs and VCs of both tech and internet firms is more positively associated with IPO values.

Overall, our results suggest that a careful examination of how IPO valuation evolves over time is warranted. Obviously, fundamentals change and this has a direct impact on IPO valuation. In addition, changes in fundamentals affect the inference problem for investors searching for signals of IPO quality. We view our results as a potentially promising start for research that focuses on understanding these valuation differences.

Appendix A: Functional form

Historically, valuation studies have adopted a linear specification. Recently, however, Hand (2003) provides evidence that the log-linear model provides a better fit than the traditional linear model. Relatedly, Burgstahler and Dichev (1997) and Fischer and Verrechia (1997) argue for a non-linear relationship between market value and net income.

In general, using the logarithm specification offers two econometric advantages: reduction in heteroscedasticity of the residuals and reduction of the influence of outliers. In addition, we use the Box and Cox (1964) method for choosing the optimal transformation of the dependent and independent variables. The Box-Cox technique has been used elsewhere in the finance literature for choosing the optimal transformation of the dependent and independent variables; for example, see Eckbo, Giammarino and Heinkel (1990), Quigg (1993), and Humphrey and Pulley (1997). This method requires specifying a family of transformations indexed by a parameter λ so the choice of the transformation is reduced to estimation of λ. If λ is equal to 0, then the logarithm model is the preferred specification; if it is equal to 1, then the linear specification is preferred. In untabulated analysis, as summarized in Appendix Figure 1, we find that $\lambda = 0.1$. The logarithmic transformation is suggested because λ is closer to zero than one.

Appendix B: IPO valuation model

We consider a simple model of initial public offering (IPO) stock price valuation based on Leland and Pyle (1977) with two modifications. First, we consider two separate and independent signals.[39] Second, we derive testable comparative statics in the Leland and Pyle framework which we test in the main text.

Firms going public need to raise an amount I. Specifically, entrepreneurs take firms public because they have an investment opportunity where the cost of the investment opportunity is normalized to I across firms. This investment opportunity differs in terms of the cash flow it generates according to firms' types (τ). Cash flow as a (continuous) function of a firm's type is $C(\tau)$ where $C'>0$. The firm's type is private information to the entrepreneur. All firms have cash flows that grow at rate g.

For simplicity, we assume that all firms last in perpetuity. Furthermore, we assume that the firm is valued according to the market conditions at the time that the firm goes public, with discount rate r. The expected value of a firm after having gone public is:

$$E(V_1) = \frac{C(\tau)}{r - g}. \quad (3)$$

Better firms would clearly like to separate themselves from lower quality firms in order to achieve higher valuations. Here we consider two mechanisms through which this might be possible. First, as in Leland and Pyle (1977), insiders may choose to retain equity in the IPO, and this can serve as a signal of firm quality. Second, the firm can choose to use a more reputable investment bank to serve as a signal of quality. We consider each of these mechanisms separately.

The timing is as follows. At time 0, the firm goes public. Insiders choose to retain a fractional amount of equity α and sell $1-\alpha$. They must also choose to hire an investment bank. The investment bank captures some amount of firm value. This could be because the investment bank intentionally underprices the IPO and recaptures some of this value from its clients through spinning, laddering, or tying arrangements. Alternatively, the investment bank extracts a commitment for future investment banking services from the firm (at noncompetitive rates). In a relative sense, this could also be due to prestigious investment bankers charging more (for example, no discounts on the standard 7% fee), or maintaining tighter control over allocations of the IPO. Firms may choose to accept this arrangement because it generates positive future analyst coverage or because it allows insiders to profit at a later date. The dollar value of proceeds that accrue to the investment bank is δB, where B (for now) is some constant

[39] We could also consider joint signals as opposed to independent signals in this framework. Doing so would not change our comparative statics, but would add complexity without much additional insight.

dollar value and δ is the quality of the investment bank. In other words, δ indexes the cost of hiring a more prestigious investment banker. As a result, better quality investment banks charge more for their services. Therefore, choosing a prestigious investment banker to take the firm public is a signal of quality, and causes the market to update its beliefs about the quality of the firm going public.

At time 1, the firm's cash flows (which depend upon its type) are revealed, but firm value is realized with some noise:

$$\tilde{V}_1 = \frac{C(\tau)}{r - g} + \varepsilon, \tag{4}$$

where ε is a normally distributed error term with mean 0 and variance σ^2. In particular, this implies that the firm's type cannot be perfectly inferred from its time 1 value, which we will need for the signaling models below. The firm's expected value at time 0 given full information about the firm's type is then:

$$E(V_0) = \frac{1}{1+r}\frac{C(\tau)}{r - g}. \tag{5}$$

Given that at time 0 the firm will hire an investment bank and sell a fraction $1-\alpha$ of the firm in the IPO, the net value of IPO proceeds to the firm (or the firm's insiders) is:

$$(1-\alpha)E(V_0(\tau)). \tag{6}$$

We assume that the firm's insiders have access to an alternative investment in which they can invest any surplus IPO proceeds beyond what is needed to fund the investment project I. The amount invested in this alternative is Y, so that:

$$(1-\alpha)E(V_0(\tau)) = I + Y + \delta B. \tag{7}$$

The amount Y earns a rate of interest, which for simplicity we set equal to r. We also note that the investment bank's payment or the value that accrues to the investment bank comes out of the IPO proceeds.

We assume that insiders try to maximize their end of time 1 utility. We assume that insiders have negative exponential utility functions with coefficient of absolute risk aversion equal to b. We assume insiders are undiversified, and therefore value their equity position at less than the market value. This is consistent with the idea that insiders are restricted from trading out of their equity positions.

Insiders' wealth at the end of time 1 is given by:

$$W_1 = \alpha V_1(\tau) + (1+r)Y. \tag{8}$$

The first part of this expression is the market value of insiders' holdings in the firm at time 1. The second part of this expression is the value of any excess IPO proceeds, grossed up by the discount rate r. Substituting for Y, we get:

$$W_1 = \alpha V_1(\tau) - (1+r)\delta B + (1+r)(1-\alpha)E(V_0(\tau)) - (1+r)I. \tag{9}$$

Insiders' expected utility is then given by:

$$u(W_1) = \alpha \frac{C(\tau)}{r-g} - (1+r)\delta B + (1+r)(1-\alpha)E(V_0(\tau)) - (1+r)I - \frac{b}{2}\alpha^2\sigma^2. \tag{10}$$

The first part of this expression is the insiders' holdings expressed in terms of expected discounted cash flows, which depend upon the firm's quality. The second part of this expression is the time 1 value of the payment to the investment bank. The third part of the expression is the time 1 value of the IPO proceeds, which are used to fund the investment project (the fourth part of the expression). The last part of the expression is the cost of risk borne by the insiders. Because they are undiversified, the insiders bear additional risk beyond the market risk premium incorporated in the discount rate r according to their coefficient of absolute risk aversion b and the variance of cash flows σ^2.

The setup so far describes the full information benchmark. Suppose instead that the market does not know the firm's type when trying to ascribe a value to the firm at the IPO. In this case, good firms (better types) have an incentive to try to separate themselves from bad firms. We now consider two mechanisms by which firms can signal their quality: insider ownership retention (α) and investment banker quality (δ). We consider each mechanism in turn.

A. Signaling with Insider Retention

As in Leland and Pyle (1977), insider retention can serve as a signal of firm quality. In this case, upon seeing a level of insider retention α, the market ascribes an expected value to the firm at the time of the IPO of:

$$E(V_0(\alpha)) = \frac{1}{1+r}\frac{C(\alpha)}{r-g}. \tag{11}$$

Insiders' utility is then given by:

$$u(W_1) = \alpha\frac{C(\tau)}{r-g} - (1+r)\delta B + (1+r)(1-\alpha)E(V_0(\alpha)) - (1+r)I - \frac{b}{2}\alpha^2\sigma^2. \tag{12}$$

This expression is identical to that in equation (10) with one difference. Here the IPO proceeds depend upon the market's expectations of firm value ($E(V_0(\alpha))$) conditional on seeing insider retention of α. Thus, α is a signal of firm quality.

The first order condition for insiders' utility with respect to insider retention α is:

$$\frac{C(\tau)}{r-g} - \frac{C(\alpha)}{r-g} + \frac{1-\alpha}{r-g}\frac{\partial C}{\partial\alpha} - b\alpha\sigma^2 = 0. \tag{13}$$

The second order condition is satisfied as well. Imposing the equilibrium condition that the market's beliefs about future cash flows must be correct given the insider retention signal, $C(\tau)=C(\alpha)$, implies that the insider retention schedule α is given by the solution to:

$$\frac{1-\alpha}{r-g}\frac{\partial C}{\partial\alpha} - b\alpha\sigma^2 = 0, \tag{14}$$

which we can rewrite as follows:

$$\frac{\partial \mathrm{C}}{\partial \alpha} = \frac{\mathrm{b}\alpha\sigma^2(\mathrm{r} - \mathrm{g})}{1 - \alpha}. \tag{15}$$

Note that if the market valuation schedule for future cash flows as a function of insider retention is increasing, C′(α)>0, then the above equation is well-defined (for further elaboration, see Leland and Pyle). The solution to the differential equation above is:

$$C(\alpha) = -\mathrm{b}\sigma^2(\mathrm{r} - \mathrm{g})[\ln(1 - \alpha) + \alpha] + \mathrm{I}, \tag{16}$$

after imposing the boundary condition of C(0)=I.

Using the Implicit Function Theorem, the following comparative statics with regard to insider retention follow immediately from (15):

$$\frac{\partial \alpha}{\partial b} < 0, \frac{\partial \alpha}{\partial \sigma^2} < 0, \frac{\partial \alpha}{\partial r} < 0, \; and \; \frac{\partial \alpha}{\partial g} > 0. \tag{17}$$

The first two comparative statics state that if insiders are more risk averse or the firm’s cash flows are riskier, then insiders will retain less equity. The third comparative static says as the discount rate increases, insider retention decreases. Finally, as the expected growth rate of cash flows increases, insider retention increases.

The following are comparative statics with regard to the market's valuation of the firm at time 0 (the time of the IPO):

$$\frac{\partial E(V_0)}{\partial r} < 0, \frac{\partial E(V_0)}{\partial g} > 0, \frac{\partial E(V_0)}{\partial \alpha} > 0. \tag{18}$$

The first two comparative statics are obvious—increases in the discount rate decrease firm value and increases in the expected growth rate increase firm value. The third comparative static follows immediately from signaling through insider retention—greater insider retention is associated with higher firm value.

We also have the following additional comparative statics:

$$\frac{\partial^2 E(V_0)}{\partial \alpha \partial r} < 0, \frac{\partial^2 E(V_0)}{\partial \alpha \partial g} > 0, \; and \; \frac{\partial^2 E(V_0)}{\partial r \partial g} < 0. \tag{19}$$

The first comparative static says that the marginal effect of insider retention on firm value is decreasing in the discount rate. Higher discount rates flatten the signaling schedule. The second comparative static says that the marginal effect of insider retention on firm value is increasing in the expected growth rate—higher growth rates make the signaling schedule steeper. These two comparative statics are unique and are tested in the paper as:

H_1: Increases in discount rates should decrease the responsiveness of firm value to insider retention (the signaling schedule should flatten).

H_2: Increases in growth rates should increase the responsiveness of firm value to insider retention (the signaling schedule should become steeper).

The third comparative static simply states that the marginal effect of growth rates on firm value is decreasing in the discount rate, a consequence of the constant growth perpetuity assumption which is not unique to the signaling model.

B. Signaling with Investment Banker Quality

Investment banker quality can also serve as a signal of firm quality.[40] In this case, upon seeing an investment banker of quality δ chosen by the firm, the market ascribes an expected value to the firm at the time of the IPO of:

$$E(V_0(\delta)) = \frac{1}{1+r}\frac{C(\delta)}{r-g}. \tag{20}$$

Insiders' utility is then given by:

[40] We note that there are many mechanisms which could be used to signal firm quality at the time of the IPO. In addition to investment banker quality and insider retention, others that have been mentioned prominently in the literature include the degree of IPO underpricing itself and the length and extent of lockup periods on insider selling. The theoretical framework can easily accommodate such signals by simply labeling them δ (and then showing that they are less costly for better type firms). In particular, all of the comparative statics will apply exactly as derived to these alternative signals δ. We choose not to focus on these alternative mechanisms for several reasons. First, Ritter and Welch (2002) argue that the signaling explanation for IPO underpricing is inadequate. Consistent with this, Aggarwal, Purnanandam, and Wu (2005) argue that underwriter manipulation explains IPO underpricing in the boom period and not a desire to signal firm quality. Second, decisions such as the choice of lockup period have now become

$$u(W_1) = \alpha \frac{C(\tau)}{r - g} - (1+r)\delta B(\tau) + (1+r)(1-\alpha)E(V_0(\delta)) - (1+r)I - \frac{b}{2}\alpha^2\sigma^2. \qquad (21)$$

This expression is identical to that in equation (10) with two differences. Here the IPO proceeds depend upon the market's expectations of firm value ($E(V_0(\delta))$) conditional on seeing an investment banker of quality δ. Second, in this formulation, we assume that better type firms have lower costs of using an investment banker of given quality, so $B'<0$. We can justify this assumption in several ways. First, better firms require less marketing effort by investment banks, which may then potentially pass some of these savings to the firm. While investment banking contracts typically have a standard 7% fee (see Chen and Ritter (2000)) associated with an IPO, banks may provide various pecuniary and nonpecuniary concessions to firms. For example, the banks may provide additional advisory services to the firm, provide more or better analyst coverage, or allow top executives of the firm to participate in other IPOs. Further, there is evidence that better investment banks prefer better firms to take public (see, for example, Fernando, Gatchev, and Spindt (2005)), which suggests that for lower quality firms, the cost of using a very good investment bank may be effectively infinite. Of course, we assume that the cost schedule is continuous in firm type.

The first order condition for insiders' utility with respect to investment banker quality is:

$$\frac{1-\alpha}{r - g}\frac{\partial C}{\partial \delta} - (1+r)B(\tau) = 0. \qquad (22)$$

The second order condition for a maximum is that $C''<0$. The equilibrium condition in this case is that there is a one-to-one function that maps τ into δ so that δ is increasing in τ. As a result, we also have that $C'>0$, so that the market's expectations of future cash flows are increasing in investment banker quality.

The following comparative statics then hold:

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standardized in practice. To the extent that such choices have information content, it would be in the context of a signal jamming equilibrium, rather than the signaling we consider here.

$$\frac{\partial \delta}{\partial r} < 0, \frac{\partial \delta}{\partial g} > 0, \text{and} \frac{\partial \delta}{\partial \alpha} < 0. \quad (23)$$

The first comparative static says that as the discount rate increases, the value of signaling decreases, while the second says that as the growth rate increases, the value of signaling increases. These comparative statics are obvious—as the returns to signaling increase, the amount of signaling we observe will increase. The third comparative static is that as insider retention increases, the value of signaling through investment banker prestige decreases. This is because signaling acts on the amount of the firm that is sold—if less of the firm is sold, then there is less value to signaling that the piece sold in the IPO is of high quality. Note here that insider retention is taken to be exogenous, in contrast to the results in the previous subsection.

The following are comparative statics with regard to the market's valuation of the firm at time 0 (the time of the IPO):

$$\frac{\partial E(V_0)}{\partial \delta} > 0, \frac{\partial E(V_0)}{\partial r} < 0, \frac{\partial E(V_0)}{\partial g} > 0, \frac{\partial^2 E(V_0)}{\partial \delta \partial r} < 0, \frac{\partial^2 E(V_0)}{\partial \delta \partial g} > 0, \; and \; \frac{\partial^2 E(V_0)}{\partial r \partial g} < 0. \quad (24)$$

These comparative statics are straightforward. In this model, firm value is increasing in investment banker quality due to the value of signaling. Firm value is decreasing in the discount rate but increasing in the growth rate. The marginal effect of signaling through investment banker quality on firm value is decreasing in the discount rate but increasing in the growth rate. This pair of comparative statics is unique, and we test them in the paper as:

H_3: Increases in discount rates should decrease the responsiveness of firm value to investment banker prestige (the signaling schedule should flatten).

H_4: Increases in growth rates should increase the responsiveness of firm value to investment banker prestige (the signaling schedule should become steeper).

The last comparative static is that the marginal effect of the growth rate on firm value is decreasing in the discount rate, which is not unique to the signaling model.

In this setup, we have considered two separate and distinct signals for one source of type uncertainty; note that this is different from the approach in Grinblatt and Hwang (1989), who consider two types of signals and two sources of asymmetric information. Given that both types of signals are available to firms in our setup, they will choose the one that is least costly.[41] Which they choose (if either) is ultimately an empirical question, which we address in the paper. It would also potentially be interesting to consider a model in which some of each signal could be chosen. We have given this issue some thought, but given our empirical focus in this paper, it is beyond the scope of what we wish to accomplish with the theory here. Nonetheless, this is an interesting problem in multidimensional signaling, which would be a fruitful avenue for future research.

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[41] Specifically, insiders will maximize expected utility over the choice of insider retention and investment banker prestige, which is a function exactly as specified in equation 21 with $E(V_0(\delta))$ replaced by $E(V_0(\alpha,\delta))$. The first order conditions will then follow equations 13 and 22 and the rest of the analysis follows under the assumption that only one of the two signals is chosen.

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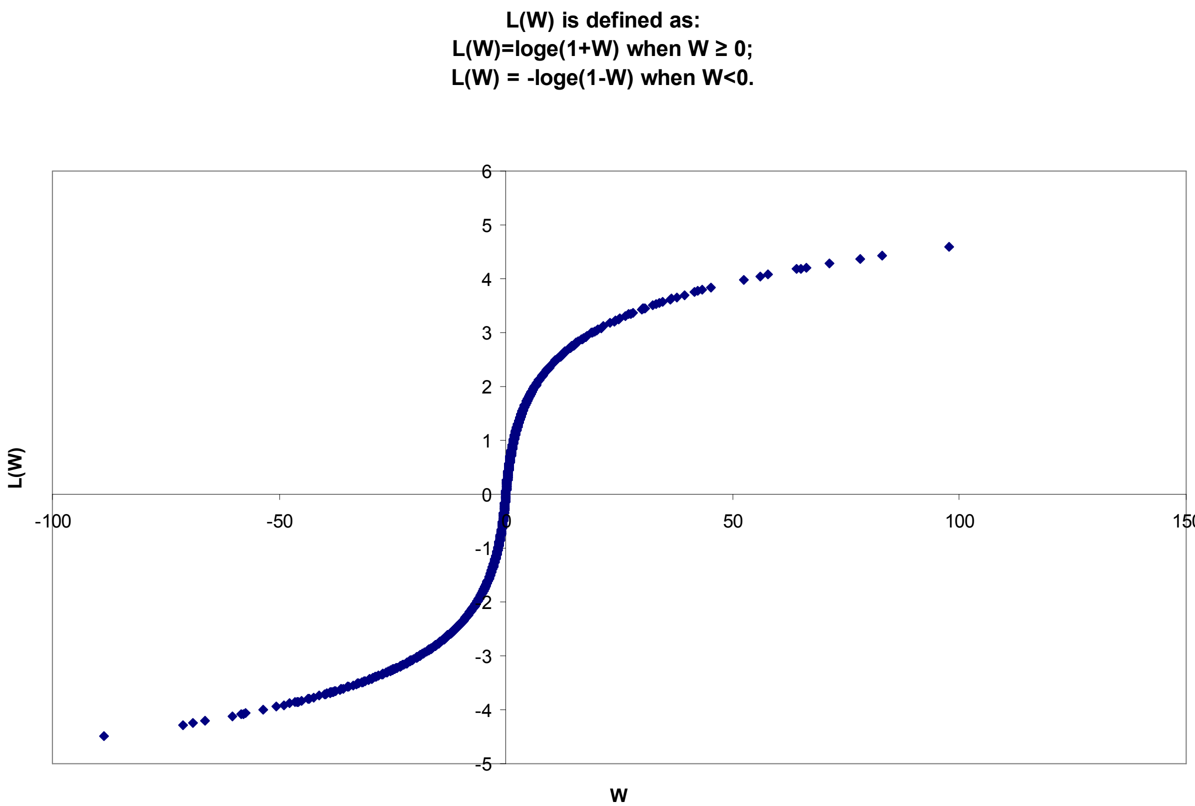


Fig. 1. Graphical illustration of L(W). L(W) is defined as: $L(W)=\log_e(1+W)$ when $W \geq 0$; $L(W) = -\log_e(1-W)$ when $W<0$. W is in millions of dollars, and equals income before R&D and extraordinary items.

Table 1
Summary statistics of 1,855 US IPOs during 1986-1990 and 1997-2001

Year	Number of IPOs	Offer value	Market Value	Sales	Income	Book value of equity	R&D	Industry Price-to-sales multiple	Insider retention	Investment banker prestige
Panel A: Means										
1986	230	85.3	94.0	71.5	2.1	7.9	1.0	5.3	0.70	7.7
1987	179	111.6	119.7	79.0	2.1	8.4	1.1	7.8	0.70	7.7
1988	70	118.3	124.2	111.5	4.6	24.6	1.5	2.8	0.73	7.6
1989	77	95.4	103.5	104.5	2.9	9.0	1.7	3.8	0.70	7.9
1990	77	134.8	148.9	277.3	4.3	9.1	1.5	4.7	0.70	8.0
1997	330	168.1	199.2	96.7	-24.3	-14.0	4.7	8.1	0.68	7.2
1998	197	219.3	283.3	82.1	-2.0	61.6	1.9	6.8	0.72	7.5
1999	359	402.9	920.2	42.0	-7.6	-1.5	3.2	72.9	0.79	8.3
2000	285	578.6	1104.0	45.4	-13.0	3.3	5.9	82.5	0.82	8.5
2001	51	467.7	572.3	197.8	-4.8	13.7	5.1	11.6	0.75	8.4
Panel B: Medians										
1986	230	49.0	51.3	27.7	1.1	4.0	0.0	2.5	0.70	8.1
1987	179	58.0	62.1	26.1	1.2	3.7	0.0	2.7	0.72	8.8
1988	70	61.5	72.6	29.3	1.4	3.3	0.0	1.7	0.75	8.8
1989	77	67.5	76.3	33.6	1.9	5.7	0.0	2.7	0.72	8.8
1990	77	77.6	84.0	30.0	1.4	4.9	0.2	3.0	0.71	8.8
1997	330	99.2	106.6	24.2	0.7	4.4	0.0	3.2	0.70	8.1
1998	197	147.5	166.0	22.2	-0.1	2.4	0.0	3.9	0.73	8.1
1999	359	291.7	425.1	8.2	-5.6	-0.2	1.6	31.7	0.81	9.1
2000	285	377.9	473.4	8.6	-8.9	-0.2	3.7	39.2	0.82	9.1
2001	51	321.5	356.4	68.0	-3.7	-2.2	0.0	3.0	0.76	9.1

Panel C: Frequencies

Year	% of loss firms	% of Technology IPOs	% of Internet IPOs
1986	21.7	20.4	--
1987	19.6	25.1	--
1988	21.4	30.0	--
1989	22.1	33.8	--
1990	20.8	31.2	--
1997	42.7	35.8	3.3
1998	53.3	43.7	17.3
1999	80.5	64.9	59.1
2000	84.9	58.2	38.2
2001	68.6	35.3	5.9

Offer value = Final offer price × number of shares outstanding immediately after the IPO (in $millions).
Market value = First-day closing price × number of shares outstanding immediately after the IPO (in $millions).
Income = Income before extraordinary items (in $millions).
R&D = Research and Development costs (in $millions).
Price-to-sales multiples are the median industry price to sales ratio for the five or fewer most recent IPOs within two years before the IPO date.
Insider retention = Percentage (÷100) of post-IPO shares outstanding retained by pre-offering shareholders.
Investment banker prestige is from Loughran and Ritter (2004).
Income, book value of equity, sales, and R&D are measured for year –1 where year –1 is the fiscal year immediately before the offering date.
Loss firms are firms with income before extraordinary items less than zero.
Technology firms and internet firms are classified according to definitions contained in Loughran and Ritter (2004).

Table 2
Relation between IPO values and time period dummies, accounting variables, growth proxies, investment banker prestige, and insider retention
Sample of 1,655 US IPOs completed in 1986-1990 and 1997-2001.

Independent Variables	L(Offer Value)	L(Total Market Value)	L(Offer Value)	L(Total Market Value)
Intercept	4.18 (106.1)	4.25 (106.8)	-0.77 (-6.2)	-1.31 (-8.6)
Boom	1.03 (19.7)	1.27 (21.9)	0.79 (22.1)	0.92 (22.7)
Crash	1.70 (25.4)	1.87 (24.4)	0.95 (17.5)	0.90 (13.7)
L(Income)	--	--	-0.07 (-5.7)	-0.09 (-6.0)
L(BV)	--	--	0.01 (1.4)	0.01 (.9)
L(Sales)	--	--	0.15 (10.4)	0.14 (8.3)
L(R&D)	--	--	0.07 (3.1)	0.11 (3.8)
L(Price-to-sales Comparable)	--	--	0.07 (5.5)	0.10 (6.4)
Investment banker prestige	--	--	0.24 (23.9)	0.25 (21.0)
Insider Retention	--	--	3.58 (19.3)	4.31 (19.3)
Adjusted R^2	0.267	0.261	0.743	0.710

Offer value = Final offer price*number of shares outstanding immediately after the IPO (in $ millions).
Market value = First-day closing price * number of shares outstanding immediately after the IPO (in $ millions).
Boom = 1 if the offer date is during 1/1997-3/2000, and 0 otherwise.
Crash = 1 if the offer date is during 4/2000-12/2001, and 0 otherwise.
L(W) is defined as: $L(W)=\log_e(1+W)$ when $W \geq 0$; $L(W) = -\log_e(1-W)$ when $W<0$
Income = Income before extraordinary items and research and development costs in year –1 (in $ millions).
Sales = Revenues in year –1(in $ millions).
BV = Book value of equity at the end of year –1(in $ millions).
R&D = Research and development costs in year -1(in $ millions).
Price-to-sales comparable= Median Industry price-to-sales ratio.
Investment banker prestige is based on Loughran and Ritter (2004).
Insider retention = Percentage of post-IPO shares outstanding retained by pre-offering shareholders.
White heteroscedasticity-consistent t-statistics are in parentheses.

Table 3
Three-stage Least Squares Regression of 3-equations system for offer value, insider retention, and investment banker prestige
Sample of 1,655 US IPOs completed in 1986-1990 and 1997-2001.

Independent variables	L(Offer Value)	Insider Retention	Investment Banker Prestige
Intercept	-1.32 (-6.6)	0.37 (21.7)	2.52 (7.6)
Boom	0.86 (24.3)	-0.06 (-9.7)	-1.30 (-13.1)
Crash	1.02 (19.2)	-0.06 (-6.4)	-1.50 (-9.9)
L(Income)	-0.03 (-4.8)	--	--
L(Sales)	0.10 (5.5)	--	--
L(BV)	0.01 (1.9)	--	--
L(R&D)	0.02 (1.4)	0.01 (5.4)	--
L(Price-to-sales comparable)	0.02 (2.3)	0.01 (4.7)	--
Investment banker prestige	0.32 (7.3)	--	--
Insider Retention	3.80 (7.8)	--	--
L(Offer Value)	--	0.08 (18.1)	1.29 (17.6)
Post-IPO Return	--	0.004 (2.7)	--
CEO% Change	--	--	-2.42 (-3.8)
CEO% After	--	--	0.15 (0.5)
R^2	.728	.474	.478

Offer value = Final offer price*number of shares outstanding immediately after the IPO (in $ millions).
Market value = First-day closing price * number of shares outstanding immediately after the IPO (in $ millions).
Boom = 1 if the offer date is during 1/1997-3/2000, and 0 otherwise.
Crash = 1 if the offer date is during 4/2000-12/2001, and 0 otherwise.
L(W) is defined as: $L(W)=\log_e(1+W)$ when $W \geq 0$; $L(W) = -\log_e(1-W)$ when $W<0$.
Income = Income before extraordinary items and research and development costs in year –1 (in $ millions).
Sales = revenues in year –1(in $ millions).
BV = Book value of equity in year –1(in $ millions).
R&D = Research and development costs in year -1(in $ millions).

Price-to-sales comparable= Median Industry price-to-sales ratio.
Investment banker prestige is based on Loughran and Ritter (2004).
Insider retention = Percentage of post-IPO shares outstanding retained by pre-offering shareholders.
CEO% Before = Percentage ownership of CEO before IPO.
CEO% After = Percentage ownership of CEO after IPO.
CEO% Change = CEO% Before – CEO% After.
Post-IPO Return: Daily-compounded buy-and-hold returns for the 260 trading days subsequent to the IPO.
White heteroscedasticity-consistent t-statistics are in parentheses.

Table 4
Inter-temporal differences and inter-industry differences in IPO valuation of accounting variables, growth proxies, investment banker prestige, and insider retention
Sample of 1,655 US IPOs completed in 1986-1990 and 1997-2001.

Independent Variables	**L(Offer Value)**	**L(Market Value)**
Intercept	0.31 (1.5)	0.47 (2.0)
Boom	0.32 (1.2)	-0.13 (-0.5)
Crash	0.60 (1.3)	0.57 (1.0)
L(Income)	0.21 (5.2)	0.21 (4.6)
L(Sales)	0.22 (8.3)	0.22 (7.5)
L(BV)	-0.003 (-.2)	-0.003 (-.2)
L(R&D)	0.13 (3.4)	0.11 (2.5)
L(Price-to-sales comparable)	0.07 (2.7)	0.07 (2.6)
Investment banker prestige	0.15 (11.2)	0.13 (8.9)
Insider retention	2.12 (6.6)	2.17 (6.0)
Boom*L(Income)	0.07 (2.0)	0.06 (1.8)
Boom*L(Sales)	-0.13 (-3.9)	-0.12 (-3.5)
Boom*L(BV)	-0.004 (-.2)	-0.007 (-0.3)
Boom*L(R&D)	-0.15 (-3.4)	-0.14 (-2.8)
Boom*L(Price-to-sales comparable)	0.02 (.6)	0.07 (1.7)
Boom*Investment banker prestige	0.10 (6.4)	0.13 (7.4)
Boom*Insider retention	-0.06 (-.1)	0.27 (0.6)
Crash*L(Income)	0.08 (2.0)	0.08 (1.7)
Crash*L(Sales)	-0.19 (-5.3)	-0.20 (-4.7)
Crash*L(BV)	0.05 (1.9)	0.05 (1.9)
Crash*L(R&D)	-0.06 (-1.1)	-0.03 (-.3)

Crash*L(Price-to-sales comparable)	-0.10 (-2.6)	-0.10 (-2.1)
Crash*Investment banker prestige	0.18 (5.7)	0.23 (5.4)
Crash*Insider retention	-0.51 (-0.9)	-0.96 (-1.4)
Tech*L(Income)	0.05 (2.3)	0.07 (2.7)
Tech*L(Sales)	-0.03 (-1.1)	-0.05 (-1.7)
Tech*L(BV)	-0.02 (-1.3)	-0.02 (-1.2)
Tech*L(R&D)	-0.07 (-1.4)	-0.02 (-.4)
Tech*L(Price-to-sales comparable)	0.01 (0.6)	0.02 (0.7)
Tech*Investment banker prestige	-.02 (-0.9)	-0.01 (-0.5)
Tech*Insider retention	1.40 (4.1)	1.71 (4.0)
Tech	-0.86 (-3.8)	-1.07 (-3.7)
Internet*L(Income)	0.02 (.9)	0.05 (1.3)
Internet*L(Sales)	-0.09 (-2.3)	-0.08 (-2.0)
Internet*L(BV)	0.03 (1.6)	0.04 (1.9)
Internet*L(R&D)	0.07 (1.6)	0.14 (2.2)
Internet*L(Price-to-sales comparable)	-0.06 (-2.2)	-0.10 (-2.6)
Internet*Investment banker prestige	-0.08 (-2.7)	-0.09 (-2.2)
Internet*Insider retention	1.50 (2.7)	2.45 (3.3)
Internet	-0.03 (-0.1)	-0.46 (-0.9)
Loss*L(Income)	-0.49 (-11.3)	-0.48 (-9.1)
Loss* Investment banker prestige	-0.003 (-0.2)	-0.001 (-0.01)
Loss*Insider retention	0.60 (1.6)	0.76 (1.7)
Loss	-0.10 (-0.4)	-0.24 (-0.8)
Adjusted R^2	0.799	0.771

L(W) is defined as: $L(W)=\log_e(1+W)$ when $W \geq 0$; $L(W) = -\log_e(1-W)$ when $W<0$
Offer value = Final offer price*number of shares outstanding immediately after the IPO (in $ millions).

Market value = First-day closing price * number of shares outstanding immediately after the IPO (in $ millions).
Boom = 1 if the offer date is during 1/1997-3/2000, and 0 otherwise.
Crash = 1 if the offer date is during 4/2000-12/2001, and 0 otherwise.
Income = Income before extraordinary items and research and development costs in year –1 (in $ millions).
Sales = Revenues in year –1(in $ millions).
BV = Book value of equity in year –1(in $ millions).
R&D = Research and development costs in year -1(in $ millions).
Price-to-sales comparable= Median Industry price-to-sales ratio.
Investment banker prestige is based on Loughran and Ritter (2004).
Insider retention = Percentage of post-IPO shares outstanding retained by pre-offering shareholders.
Loss = 1 if income before extraordinary items is negative, and 0 otherwise.
Tech = 1 if a firm belongs a technology industry, and 0 otherwise.
Internet = 1 if a firm belongs to an internet industry, and 0 otherwise.
Technology firms and internet firms are classified based on definitions in Loughran and Ritter (2004).
White heteroscedasticity-consistent t-statistics are in parentheses.

Table 5
Robust regression IPO valuation:
Inter-temporal differences and inter-industry differences in IPO valuation of accounting variables, growth proxies, investment banker prestige and insider retention
Sample of 1,655 US IPOs completed in 1986-1990 and 1997-2001.

	L(Offer Value) **Robust Regression**	**L(Market Value)** **Robust Regression**
Independent Variables		
Intercept	.48 (13.0)	.67 (15.4)
Boom	.11 (2.45)	-.17 (-3.3)
Crash	.68 (7.6)	.39 (3.8)
L(Income)	.23 (33.0)	.25 (30.8)
L(Sales)	.20 (45.0)	.19 (36.4)
L(BV)	.01 (4.50)	.01 (3.3)
L(R&D)	.16 (19.6)	.13 (13.9)
L(Price-to-sales comparable)	.07 (12.6)	.08 (12.2)
Investment banker prestige	.13 (43.5)	.12 (34.3)
Insider retention	1.99 (38.4)	1.96 (32.5)
Boom*L(Income)	.07 (12.1)	.06 (8.0)
Boom*L(Sales)	-.11 (-21.2)	-.11 (-17.0)
Boom*L(BV)	-.02 (-5.2)	-.03 (-7.5)
Boom*L(R&D)	-.17 (-19.3)	-.17 (-16.1)
Boom*L(Price-to-sales comparable)	.03 (4.2)	.06 (7.7)
Boom*Investment banker prestige	.11 (29.7)	.14 (32.2)
Boom*Insider retention	.16 (2.5)	.30 (4.1)
Crash*L(Income)	.09 (13.8)	.09 (10.9)
Crash*L(Sales)	-.17 (-25.7)	-.17 (-22.2)
Crash*L(BV)	.01 (3.8)	.02 (4.4)

Crash*L(R&D)	-.09 (-8.5)	-.05 (-4.2)
Crash*L(Price-to-sales comparable)	-.09 (-12.0)	-.1 (-11.1)
Crash*Investment banker prestige	.17 (22.3)	.23 (25.0)
Crash*Insider retention	-.53 (-4.7)	-.71 (-5.5)
Tech*L(Income)	.06 (17.1)	.05 (13.1)
Tech*L(Sales)	-.05 (-10.1)	-.05 (-9.9)
Tech*L(BV)	-.02 (-6.4)	-.02 (-5.6)
Tech*L(R&D)	-.09 (-13.0)	-.04 (-5.2)
Tech*L(Price-to-sales comparable)	.01 (1.9)	.01 (2.7)
Tech*Investment banker prestige	-.02 (-5.2)	-.01 (-2.4)
Tech*Insider retention	1.55 (26.5)	1.68 (24.6)
Tech	-.87 (-21.8)	-1.02 (-21.8)
Internet*L(Income)	-.01 (-2.5)	.07 (13.9)
Internet*L(Sales)	-.05 (-9.4)	-.08 (-12.3)
Internet*L(BV)	.02 (7.7)	.04 (10.9)
Internet*L(R&D)	.07 (8.1)	.15 (15.6)
Internet*L(Price-to-sales comparable)	-.05 (-9.7)	-.09 (-14.6)
Internet*Investment banker prestige	-.09 (-16.5)	-.09 (-13.4)
Internet*Insider retention	1.54 (16.5)	2.31 (21.3)
Internet	-.12 (-1.9)	-.42 (-5.8)
Loss*L(Income)	-.51 (-70.2)	-.51 (-60.4)
Loss* Investment banker prestige	.02 (4.81)	.01 (3.3)
Loss*Insider retention	.30 (5.2)	.70 (10.3)
Loss	-.01 (-.2)	-.25 (-5.3)
	Number of Simplex iterations for theta= .1,.25,.5,.75,.9 : 289,329,335,406,301	Number of Simplex iterations for theta= .1,.25,.5,.75,.9 : 254,300,307,357,275

L(W) is defined as: $L(W)=\log_e(1+W)$ when $W \geq 0$; $L(W) = -\log_e(1-W)$ when $W<0$.
Offer value = Final offer price*number of shares outstanding immediately after the IPO (in $ millions).
Market value = First-day closing price * number of shares outstanding immediately after the IPO (in $ millions).
Income = Income before extraordinary items and research and development costs in year –1 (in $ millions).
Sales = Revenues in year –1; BV = Book value of equity in year –1 (in $ millions).
R&D = Research and development costs in year -1 (in $ millions).
Price-to-sales comparable = Median Industry price-to-sales ratio.
Investment banker prestige is based on Loughran and Ritter (2004).
Insider retention = Percentage of post-IPO shares outstanding retained by pre-offering shareholders.
Boom = 1 if the offer date is during 1/1997-3/2000, and 0 otherwise.
Crash = 1 if the offer date is during 4/2000-12/2001, and 0 otherwise.
Loss = 1 if income before extraordinary items is negative, and 0 otherwise.
Tech = 1 if a firm belongs a technology industry, and 0 otherwise.
Internet = 1 if a firm belongs to an internet industry, and 0 otherwise.
Technology firms and internet firms are classified according to definitions contained in Loughran and Ritter (2004).
“t-ratio” in parentheses. Distribution of this ratio is not well specified.

Table 6
Ownership structure of 1,855 US IPOs during 1986-1990 and 1997-2001

Panel A: Means

Year/Period	Number of IPOs	CEO% Before	CEO% After	CEO% Change	OffDir% Before	OffDir% After	OffDir% Change	VC% Before	VC% After	VC% Change	Block% Before	Block% After	Block% Change
1986	230	34.6	23.5	11.1	31.0	22.1	8.9	7.8	5.8	2.0	13.2	9.1	4.1
1987	179	31.5	22.3	9.2	26.9	18.8	8.1	10.8	7.8	3.0	17.2	11.5	5.7
1988	70	20.0	14.6	5.4	30.0	22.2	7.8	14.7	11.0	3.8	17.4	12.3	5.1
1989	77	25.0	16.8	8.2	27.4	19.3	8.1	12.2	8.9	3.3	20.6	13.4	7.2
1990	77	23.8	16.7	7.1	21.3	14.6	6.7	17.8	12.6	5.2	24.1	16.5	7.6
1997	330	27.1	18.4	8.7	28.2	19.2	9.0	12.7	8.7	4.0	17.0	11.4	5.6
1998	197	24.7	17.1	7.6	24.4	16.7	7.7	12.3	9.1	3.2	21.4	15.0	6.4
1999	359	17.7	13.4	4.3	17.6	13.8	3.8	21.7	17.0	4.8	22.6	17.3	5.3
2000	285	13.4	10.5	2.9	15.2	12.5	2.7	22.7	18.0	4.7	28.0	22.0	6.0
2001	51	18.0	13.4	4.6	14.1	10.6	3.5	21.0	15.2	5.8	31.7	23.2	8.5

Panel B: Medians

Year/Period	Number of IPOs	CEO% Before	CEO% After	CEO% Change	OffDir% Before	OffDir% After	OffDir% Change	VC% Before	VC% After	VC% Change	Block% Before	Block% After	Block% Change
1986	230	27.5	18.4	7.9	26.0	18.6	6.1	0.0	0.0	0.0	4.6	3.1	1.4
1987	179	21.3	13.4	6.4	17.8	13.0	4.8	0.0	0.0	0.0	6.6	4.3	2.3
1988	70	10.4	8.7	2.3	22.0	16.5	4.5	0.0	0.0	0.0	8.1	5.0	2.5
1989	77	14.3	10.5	4.4	18.4	12.3	5.0	0.0	0.0	0.0	14.7	8.2	3.6
1990	77	12.9	9.0	3.3	14.7	8.3	3.2	0.0	0.0	0.0	11.0	8.1	3.1
1997	330	14.0	10.0	4.0	21.0	14.0	5.0	0.0	0.0	0.0	8.0	5.0	2.0
1998	197	14.0	10.0	4.0	17.0	12.0	3.0	0.0	0.0	0.0	11.0	8.0	3.0
1999	359	9.0	7.0	2.0	13.0	10.0	2.0	19.0	15.0	3.0	15.0	12.0	3.0
2000	285	6.0	5.0	1.0	11.0	8.0	2.0	17.0	14.0	3.0	21.0	17.0	4.0
2001	51	6.0	5.0	1.0	10.0	7.0	2.0	9.0	7.0	2.0	25.0	18.0	4.0

CEO% Before = Percentage ownership of CEO before IPO.
CEO% After = Percentage ownership of CEO after IPO.
CEO% Change = CEO% Before – CEO% After.
OffDir% Before = Percentage ownership of officers and directors as a group (but not including the CEO) before IPO.
OffDir% After = Percentage ownership of officers and directors as a group (but not including the CEO) after IPO.
OffDir% Change = OffDir% Before – OffDir% After.
VC% Before = Percentage ownership of VC investors before IPO.
VC% After = Percentage ownership of VC investors after IPO.
VC% Change = VC% Before – VC% After.
Block% Before = Percentage Ownership of 5 percent blockholders (not including officers and directors of the company or VC investors) before IPO.
Block% After = Percentage Ownership of 5 percent blockholders (not including officers and directors of the company or VC investors) after IPO.
Block% Change = Block% After – Block% Before.

Table 7
Relation between IPO values and time period dummies, accounting variables, growth proxies, investment banker prestige, and detailed ownership variables
Sample of 1,655 US IPOs completed in 1986-1990 and 1997-2001.

Independent Variables	L(Offer Value)	L(Total Market Value)
Intercept	1.64 (14.7)	1.57 (12.2)
Boom	.80 (21.0)	.94 (21.7)
Crash	.98 (17.5)	.95 (14.1)
L(Income)	-.08 (-5.7)	-.10 (-5.9)
L(Sales)	.15 (10.3)	.15 (8.4)
L(BV)	.02 (1.8)	.01 (4.6)
L(R&D)	.11 (4.1)	.15 (4.6)
L(Price-to-sales comparable)	.08 (6.0)	.12 (6.7)
Investment banker prestige	.26 (23.1)	.27 (20.8)
CEO% Change	-2.33 (-7.5)	-2.52 (-6.9)
OffDir% Change	-2.00 (-5.4)	-2.38 (-5.58)
VC% Change	-3.45 (-7.4)	-4.73 (-7.8)
Block% Change	-1.50 (-5.2)	-1.96 (-6.0)
CEO% After	.76 (4.2)	.80 (3.7)
OffDir% After	.66 (3.5)	.84 (3.7)
VC% After	1.26 (5.7)	1.76 (6.3)
Block% After	.89 (5.7)	.99 (5.3)
Adjusted R^2	0.709	0.676

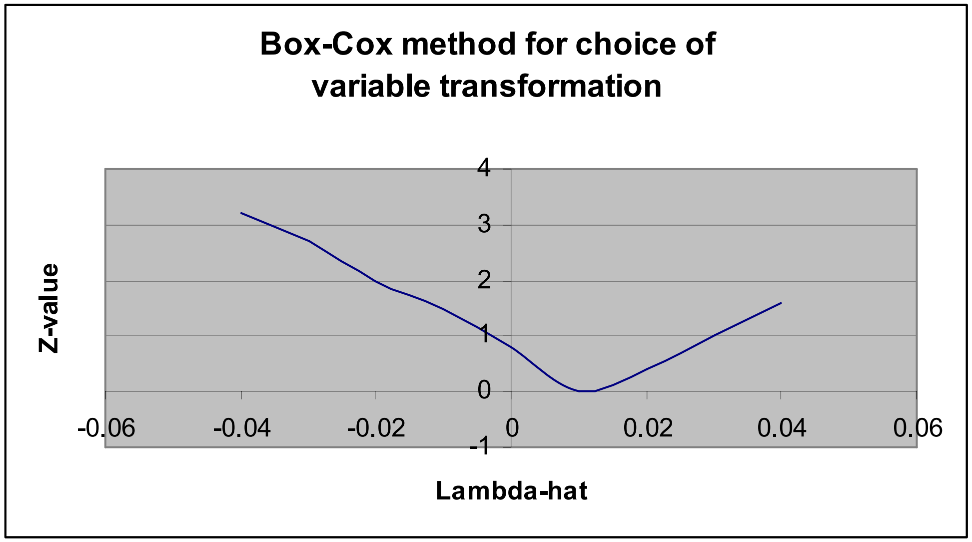
L(W) is defined as: $L(W)=\log_e(1+W)$ when $W \geq 0$; $L(W) = -\log_e(1-W)$ when $W<0$
Offer value = Final offer price*number of shares outstanding immediately after the IPO (in $ millions).
Market value = First-day closing price * number of shares outstanding immediately after the IPO (in $ millions).
Boom = 1 if the offer date is during 1/1997-3/2000, and 0 otherwise.
Crash = 1 if the offer date is during 4/2000-12/2001, and 0 otherwise.
Income = Income before extraordinary items and research and development costs in year –1 (in $ millions).
Sales = Revenues in year –1(in $ millions).
BV = Book value of equity in year –1(in $ millions).
R&D = Research and development costs in year -1. (in $ millions).
Price-to-sales comparable= Median Industry price-to-sales ratio
Investment banker prestige is based on Loughran and Ritter (2004);
CEO% Before = Percentage ownership of CEO before IPO.
CEO% After = Percentage ownership of CEO after IPO.
CEO% Change = CEO% Before – CEO% After.
OffDir% Before = Percentage ownership of officers and directors as a group (but not including the CEO) before IPO.

OffDir% After = Percentage ownership of officers and directors as a group (but not including the CEO) after IPO.
OffDir% Change = OffDir% Before – OffDir% After.
VC% Before = Percentage ownership of VC investors before IPO.
VC% After = Percentage ownership of VC investors after IPO.
VC% Change = VC% Before – VC% After.
Block% Before = Percentage Ownership of 5 percent blockholders (not including officers and directors of the company or VC investors) before IPO.
Block% After = Percentage Ownership of 5 percent blockholders (not including officers and directors of the company or VC investors) after IPO.
Block% Change = Block% After – Block% Before.
White heteroscedasticity-consistent t-statistics are in parentheses

Table 8
Inter-industry differences in IPO valuation of detailed ownership variables
Additional control variables as reported in Table 4 are included in these regressions but not reported here. Sample of 1,655 US IPOs during 1986-1990 and 1997-2001.

Independent Variables	**L(Total Offer Value)**	**L(Total Market Value)**
CEO% Change	-1.14 (-2.8)	-1.33 (-2.7)
OffDir% Change	-1.53 (-6.2)	-1.84 (-6.0)
VC% Change	0.22 (0.2)	0.87 (0.7)
Block% Change	-1.19 (-5.2)	-1.55 (-5.5)
CEO% After	0.39 (1.8)	0.39 (1.5)
OffDir% After	0.54 (3.8)	0.61 (3.4)
VC% After	-0.05 (-.1)	-0.39 (-0.7)
Block% After	0.64 (4.9)	0.66 (4.1)
Tech*CEO% Change	-1.24 (-2.0)	-1.33 (-1.7)
Tech*VC% Change	-2.69 (-3.4)	-3.82 (-3.9)
Tech*CEO% After	0.68 (2.5)	0.79 (2.4)
Tech*VC% After	0.90 (2.8)	1.35 (3.4)
Internet*CEO% Change	-0.99 (-.9)	-1.06 (-0.7)
Internet*VC% Change	-2.9 (-2.3)	-4.94 (-3.1)
Internet*CEO% After	0.73 (1.6)	0.80 (1.5)
Internet*VC% After	0.86 (2.0)	1.48 (2.8)
Adjusted R^2	0.775	0.748

L(W) is defined as: $L(W)=\log_e(1+W)$ when $W \geq 0$; $L(W) = -\log_e(1-W)$ when $W<0$
Offer value = Final offer price*number of shares outstanding immediately after the IPO (in $ millions).
Market value = First-day closing price * number of shares outstanding immediately after the IPO (in $ millions).
CEO% Before = Percentage ownership of CEO before IPO; CEO% After = Percentage ownership of CEO after IPO. CEO% Change = CEO% Before – CEO% After; VC% Before = Percentage ownership of VC investors before IPO; VC% After = Percentage ownership of VC investors after IPO; VC% Change = VC% Before – VC% After. Tech = 1 if a firm belongs a technology industry, and 0 otherwise; Internet = 1 if a firm belongs to an internet industry, and 0 otherwise. Technology firms and internet firms are classified based on definitions in Loughran and Ritter (2004).
White heteroscedasticity-consistent t-statistics are in parentheses.



Appendix Fig. 1. The Box-Cox method for choosing the optimal variable transformation.
The optimal lambda-hat is the one that minimizes the Z-value. The estimate of λ minimizes $RSS_z(\lambda)$, the residual sum of squares from the regression of $Z(\lambda)$ on x where $Z(\lambda)$ is defined by the modified power transformation:

$$Z(\lambda)= y^{(\lambda)}gm(y)^{1-\lambda}$$

where gm is the geometric mean of the observed values of y.

Appendix Table 1
Inter-temporal differences and inter-industry differences in IPO valuation of accounting variables, growth proxies, investment banker prestige, and insider retention
These are the same regression results as in Table 4 above, except the regression results have been formatted differently for compactness. Sample of 1,655 US IPOs completed in 1986-1990 and 1997-2001.

	1980s		Boom period		Crash period		Tech firms		Internet firms		Loss firms	
	Offer value	Market value	Offer value	Market value	Offer value	Market value	Offer value	Market value	Offer value	Market value	Offer value	Market value
Intercept	0.31 (1.5)	0.47 (2.0)	0.32 (1.2)	-0.13 (-0.5)	0.60 (1.3)	0.57 (1.0)	-0.86 (-3.8)	-1.07 (-3.7)	-0.03 (-0.1)	-0.46 (-0.9)	-0.10 (-0.4)	-0.24 (-0.8)
L(Income)	0.21 (5.2)	0.21 (4.6)	0.07 (2.0)	0.06 (1.5)	0.08 (2.0)	0.08 (1.7)	0.05 (2.3)	0.07 (2.7)	0.02 (.9)	0.05 (1.3)	-0.49 (-11.3)	-0.48 (-9.1)
L(Sales)	0.22 (8.3)	0.22 (7.5)	-0.13 (-3.9)	-0.12 (-3.5)	-0.19 (-5.3)	-0.20 (-4.7)	-0.03 (-1.1)	-0.05 (-1.7)	-0.09 (-2.3)	-0.08 (-2.0)	-	-
L(BV)	-0.003 (-0.2)	-0.003 (-0.2)	-0.004 (-0.2)	-0.007 (-0.3)	0.05 (1.9)	0.05 (1.9)	-0.02 (-1.3)	-0.02 (-1.2)	0.03 (1.6)	0.04 (1.9)	-	-
L(R&D)	0.13 (3.4)	0.11 (2.5)	-0.15 (-3.4)	-0.14 (-2.8)	-0.06 (-1.1)	-0.03 (-.3)	-0.07 (-2.0)	-0.02 (-.4)	0.07 (1.6)	0.14 (2.2)	-	-
L(Price-to-sales comparable)	0.07 (2.7)	0.07 (2.6)	0.02 (0.6)	0.07 (1.7)	-0.10 (-2.6)	-0.10 (-2.1)	0.01 (-0.6)	0.02 (0.7)	-0.06 (-2.2)	-0.10 (-2.6)	-	-
Investment banker prestige	0.15 (11.2)	0.13 (8.9)	0.10 (6.4)	0.13 (7.4)	0.18 (5.7)	0.23 (5.4)	1.40 (4.1)	-0.01 (-0.5)	-0.08 (-2.7)	-0.09 (-2.2)	-0.003 (-0.2)	-0.001 (-0.01)
Insider retention	2.12 (6.6)	2.17 (6.0)	-0.06 (-0.1)	0.27 (0.6)	-0.51 (-0.9)	-0.96 (-1.4)	1.40 (4.1)	1.71 (4.0)	1.50 (2.7)	2.45 (3.3)	0.60 (1.6)	0.76 (1.7)

L(W) is defined as: $L(W)=\log_e(1+W)$ when $W \geq 0$; $L(W) = -\log_e(1-W)$ when $W<0$
Offer value = Final offer price*number of shares outstanding immediately after the IPO (in $ millions).
Market value = First-day closing price * number of shares outstanding immediately after the IPO (in $ millions).
Boom = 1 if the offer date is during 1/1997-3/2000, and 0 otherwise.
Crash = 1 if the offer date is during 4/2000-12/2001, and 0 otherwise.
Income = Income before extraordinary items and research and development costs in year –1 (in $ millions).
Sales = Revenues in year –1(in $ millions).

BV = Book value of equity in year –1(in $ millions).
R&D = Research and development costs in year -1(in $ millions).
Price-to-sales comparable= Median Industry price-to-sales ratio.
Investment banker prestige is based on Loughran and Ritter (2004).
Insider retention = Percentage of post-IPO shares outstanding retained by pre-offering shareholders.
Loss = 1 if income before extraordinary items is negative, and 0 otherwise.
Tech = 1 if a firm belongs a technology industry, and 0 otherwise.
Internet = 1 if a firm belongs to an internet industry, and 0 otherwise.
Technology firms and internet firms are classified based on definitions in Loughran and Ritter (2004).
White heteroscedasticity-consistent t-statistics are in parentheses.