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The implications of IPO underpricing for the firm and insiders: Tests of asymmetric information theories

Duane B. Kennedy, Ranjini Sivakumar *, Kenneth R. Vetzal

Centre for Advanced Studies in Finance, School of Accountancy, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1

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Abstract

We assess the relative importance of various theoretical explanations of IPO underpricing by focusing on models that assume that the IPO is the first stage of a multi-stage selling scenario in an asymmetric information framework. In a two-period sell-out strategy, we find that firms are worse off due to IPO underpricing but insiders appear to maximize their wealth. The results indicate that the most compelling explanation for IPO underpricing is the entrepreneurial losses model. We also find strong support for the information momentum model and limited support for the information production, market feedback, and changing objective function models. The signaling explanation has the least support.

JEL classification: G32
Keywords: IPO; Underpricing; Sequential financing; Asymmetric information

1. Introduction

The general tendency for initial public offerings (IPOs) to be underpriced has been a subject of considerable academic and practical interest. Indeed, given severe underpricing

* Corresponding author. Tel.: +1 519 888 4567x5703; fax: +1 519 888 7562.
E-mail address: rsivakumar@uwaterloo.ca (R. Sivakumar).

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during the period 1999–2000, it would seem that interest in this area is unlikely to wane anytime soon. A wide variety of explanations have been proposed for this phenomenon. Jenkinson and Ljungqvist (2001) and Ritter and Welch (2002) review the various theories and conclude that no single theory can explain the observed underpricing. If there is no dominant theory that explains underpricing, then an interesting question that arises is which explanation is the most relevant?

This paper aims to address this issue. We attempt to differentiate among some of the competing hypotheses about IPO underpricing by focusing on explanations based on asymmetric information in a sequential financing setting. We examine a sample of U.S. IPOs for the years 1991–1998. This is an interesting period in which to test these theories because the magnitude of average underpricing was extremely high.[1] In order to determine whether issuers as well as insiders are ultimately better off, an examination of the IPO as well as subsequent events including seasoned equity offerings (SEOs) and the sale of insider shares between the IPO and SEO is required. We first examine IPO underpricing and then study the probability of seasoned equity issuance as well as the market response to SEO announcements. Since an important implication of IPO underpricing is that it raises the indirect costs of both primary and secondary equity, we focus on the impact of IPO underpricing on the proceeds received by firms and insiders in a two-stage selling strategy. If the IPO were treated as part of the firm's long-term financing strategy, then the significance of underpricing at the firm level would depend on the proportion of shares sold at the IPO and subsequent seasoned offerings. The impact of underpricing on insider wealth in a two-stage selling strategy would depend on the shares sold at the IPO and in the post-IPO period until the first SEO. Hence, we test the implications of these models for insiders of the firm and for the firms themselves from the IPO to the first seasoned equity issuance.

We find that firms are worse off due to IPO underpricing but insiders appear to maximize their wealth. Specifically, the extent to which insiders care about underpricing depends on how many shares they sell at the IPO. The more shares insiders sell, the greater their incentives to incur the costs of promoting the issue and generating information to minimize their underpricing-related wealth losses. We find that the most convincing explanation for IPO underpricing is the entrepreneurial losses model (Habib and Ljungqvist, 2001). The information momentum model (Aggarwal et al., 2002) is also strongly supported. We find limited support for the information production (Chemmanur, 1993), market feedback (Jegadeesh et al., 1993; van Bommel, 2002; van Bommel and Vermaelen, 2003) and changing objective function model (Loughran and Ritter, 2004). The signaling explanation (Allen and Faulhaber, 1989; Grinblatt and Hwang, 1989; Welch, 1989, 1996) has little support.

This research contributes to the literature in five ways. First, we explore six candidate theoretical models primarily in an asymmetric information framework to explain IPO underpricing. We use a broad and common data set to test these theories. This research design provides a consistent framework to assess the relative importance of the various

[1] In the period 1990–1998, the average underpricing was 15%. This compares to the 7.4% in the 1980s (Loughran and Ritter, 2004).

explanations. Second, we explore each theoretical model from several different perspectives. Third, we attempt to evaluate the importance of the models, from the viewpoints of the firm and the insiders. Fourth, we provide a comprehensive study of the U.S. IPO and SEO market in a period when high underpricing occurred. Finally, we use improved econometric specifications compared to most previous studies.

The remainder of the paper is divided into six sections. In the next section, we discuss the theoretical models and generate a series of testable implications. In Section 3, we discuss sample selection and characteristics. In the next three sections, we test the models. In Section 7, we summarize our conclusions.

2. Theoretical models for IPO underpricing and testable implications

Jenkinson and Ljungqvist (2001) and Ritter and Welch (2002) review the various theories that have been proposed to explain IPO underpricing. Jenkinson and Ljungqvist (2001) divide the theories into three categories; asymmetric information, institutional factors, and ownership and control considerations. Ritter and Welch (2002) classify the theories based on whether they assume asymmetric information or symmetric information. Both reviews conclude that no single theory can explain the pervasive underpricing observed across time and locale. The theories are not mutually exclusive and some may be more or less relevant than others depending on the circumstances of particular IPOs.

Our study tests the relative explanatory power of a number of these theories. We choose to focus our analysis on six theories based on information asymmetry and multiple periods. These theories have testable implications for the IPO as well as the subsequent period extending at least to the first SEO. There are a number of reasons for our decision to focus on multi-period, asymmetric information theories. We believe that information asymmetry is a reasonable characterization of the IPO environment. Previous research shows that many companies have multiple equity issues within a small time period and the pre-IPO owners may sell shares as part of the IPO, subsequent to the IPO in open market sales and as part of seasoned equity offerings.[2] Restricting the set of theories considered allows us to use a common data set to test the relative explanatory power of the theories. Finally, it is not possible to test all of the potential theories with the data available to us.

2.1. Preview of asymmetric information theories in a multi-period setting

In the remainder of the section, we discuss in detail the following six theoretical models that we focus on to explain underpricing: signaling, information production, market feedback, entrepreneurial losses, changing objective function, and the information momentum models.

Although these models are based on information asymmetry, they have some distinct differences. The signaling model and the information production model assume that the

[2] Most IPOs have share lockup agreements, which prohibit insiders and other pre-IPO shareholders from selling their shares for a specific period, typically 180 days; however, the underwriter may release the insiders from the lockup under certain conditions.

firm has the informational advantage compared to the investor while the market feedback model assumes the opposite. The signaling model assumes that there is an exogeneous release of information subsequent to the IPO, which attenuates the information asymmetry (i.e. reveals the firm type) and reduces mispricing. In contrast, the information production model and the market feedback model assume that IPO underpricing is used to induce the subsequent revelation of information from investors, which moves share prices to a more appropriate level. Specifically, the information production model assumes that the underpricing is not effective as a signal in revealing the firm type and shows that firms use underpricing as a device to encourage information production by investors.

The entrepreneurial losses model assumes that some investors are better informed than others. Consequently, owners incur the costs of promoting the issue to reduce the information asymmetry and decrease the adverse selection problem so that their underpricing-related wealth losses are minimized.

The previous models assumed asymmetric information regarding the value of the firm whereas the changing objective function model assumes that investors cannot observe the actions of the managers, suggesting a principal-agent problem between shareholders and managers.

The information momentum model differs from the other models as it does not explicitly incorporate an informational advantage for one group. Instead, the assumption is made that managers can use underpricing to reveal information through increased research coverage, creating information momentum, which shifts the demand curve for the firm's shares.

We next describe the models and the testable implications drawn from the literature.

2.2. Signaling models

A well-known category of explanations for IPO underpricing is the signaling-based theories proposed by Allen and Faulhaber (1989), Grinblatt and Hwang (1989), and Welch (1989). The works by Jegadeesh et al. (1993) and Spiess and Pettway (1997) to test these models have direct implications for our analysis. In these models, the issuer has private information about the present value of future cash flows that is unavailable to the investors. The basic intuition underlying the models is that high-quality firms are willing to bear the cost of the signal in order to distinguish themselves from low-quality firms. These models assume that firm type is revealed exogenously after the IPO. By issuing a costly signal, firms can expect to have subsequent actions such as seasoned equity offerings or dividend increases received more favorably by the market. Hence, these are two-stage selling models, where the cost of the signal is recovered at the second stage and the firm and insiders maximize the expected value of the proceeds of the two-stage sale. Allen and Faulhaber (1989) and Welch (1989) use IPO underpricing as the signal. Grinblatt and Hwang (1989) use an additional signal, the retention rate by insiders.

We examine a number of testable implications that are derived in the theoretical papers or in subsequent testing of the models. Grinblatt and Hwang (1989) show that there should be a positive relationship between IPO underpricing and insider retention at the IPO. Jegadeesh et al. (1993) argue that there should be a positive relationship between IPO

underpricing and the probability of a seasoned equity offering. Welch (1989) and Jegadeesh et al. (1993) argue that if markets view underpricing as a signal of quality, there should be a positive relationship between IPO underpricing and the stock price reaction to the seasoned equity filing. The authors also contend that there should be a positive relationship between IPO underpricing and SEO proceeds.

In these models, the firm will underprice its IPO only when it expects to obtain the benefit of selling seasoned equity at a higher price. This reflects a tradeoff of the proceeds from the initial offering against the present value of proceeds from the seasoned offering. Grinblatt and Hwang (1989) and Spiess and Pettway (1997) note that firms with the greatest underpricing will receive the greatest combined proceeds (in terms of the present value of the IPO and the first SEO). Since the retention rate by insiders can be used as a signal of quality, Spiess and Pettway (1997) argue that there should be a positive relation between insider retention at the IPO and the combined proceeds for the firm. Existing owners/managers bear the costs of the underpricing both as a wealth transfer to new shareholders when new shares are sold cheap and in lower proceeds for the shares that they have sold themselves. Insiders of high quality firms who use IPO underpricing or retention as a signal of firm quality will not want to sell their secondary shares at the IPO but will sell shares in subsequent periods. They will choose to sell their shares later in order to benefit from the IPO underpricing signal. Spiess and Pettway (1997) contend that the present value of the combined wealth change for insiders from the IPO and the subsequent period is positively related to IPO underpricing as well as insider retention at the IPO.

2.3. The information production model

Chemmanur (1993) proposes a model where insiders know the value of the firm and plan to sell shares in both the IPO and SEO. He assumes that underpricing is not effective as a signal in revealing the firm type to investors and argues that managers want to reduce the information asymmetry by inducing informed investors to produce information. The firm compensates the investors for the costly information production by underpricing the IPO. The costs include marketing efforts by investment bankers that reduce outsiders' information production costs.

According to this model, underpricing is greater for firms with projects that are costlier to assess. Specifically, Chemmanur (1993) concludes that relatively obscure firms or those with projects that are costlier to evaluate will have greater underpricing. We contend that firms that are in the high-tech sector face greater uncertainty and, as a result, are more costly to assess and will have greater underpricing.

Chemmanur (1993) shows that the firm will underprice its IPO only when it expects to obtain the benefit of selling seasoned equity at a higher price. This implies a tradeoff of the proceeds from the initial offering against the present value of proceeds from the seasoned offering. An implication of Chemmanur's (1993) model is that greater IPO underpricing is associated with lower IPO gross proceeds. His model also implies that IPO underpricing is positively related to the probability of the issuance of an SEO and the level of SEO proceeds. An additional implication is that IPO underpricing is positively related to the combined proceeds to insiders from the IPO and subsequent periods.

2.4. The market feedback model

In the market feedback model (Jegadeesh et al., 1993; van Bommel, 2002; van Bommel and Vermaelen, 2003), investors are better informed about firm value than the managers. The owner–managers choose the amount of the IPO and the offer price to maximize information production by informed investors. van Bommel (2002) assumes that analysts are informed investors. The true value of the firm is revealed to the managers by the post-IPO price. Based on the IPO underpricing and returns in the period immediately after the IPO (post-issue returns), firms revise upwards the estimated marginal returns from projects and conduct seasoned offerings to raise additional capital to finance these projects.[3] Following Jegadeesh et al. (1993), the market feedback model predicts that post-issue returns and IPO underpricing are positively related to (1) the probability of issuing seasoned equity, (2) the stock price reaction to SEO announcements and (3) SEO proceeds. Post-issue returns are better predictors than IPO underpricing for all three outcomes.

2.5. The entrepreneurial losses model

In the entrepreneurial losses model, which is an extension to Rock's (1986) asymmetric information model, Habib and Ljungqvist (2001) assume that some investors are better informed than others.[4] Consequently, the authors introduce information production at the IPO stage itself in order to decrease the adverse selection problem. Owners incur the costs of promoting the issue to reduce the information asymmetry so that their underpricing-related wealth losses are minimized. The authors argue that the extent to which owners care about underpricing depends on how many shares they sell at the IPO. The more shares that the owners sell, the greater their incentive to decrease underpricing. The costs could include those associated with choosing a reputable underwriter or auditor. Their model implies IPO underpricing should decrease with increased promotion costs (e.g. a higher-ranked underwriter) and increase with higher insider retention at the IPO and uncertainty. Habib and Ljungqvist (2001) argue that empirical tests of IPO underpricing theories should be conditioned on the owners' incentives to incur costs to reduce losses. We contend that Habib and Ljungqvist's (2001) analysis is incomplete because insiders may be made wealthier by their retained shares, but these are unrealized gains. To determine whether or not insiders are ultimately better off requires an examination of events after the IPO. Hence, we argue that a further implication of their model is that the present value of

[3] The signaling models treat the underpricing on the IPO issue date as a signal to the market and there is no role in the models for share price changes on subsequent days. The market feedback model considers returns on both the issue date and subsequent to the issue date as informative about the value of the firm.

[4] In Rock's (1986) model, the firms and the underwriter are uninformed but some investors have better information. These informed investors would bid only for the underpriced offerings resulting in the uninformed investors receiving fewer shares in the underpriced offerings and all the shares bid for in the overpriced offerings. Faced with this adverse selection problem, the uninformed investors require higher average returns to compensate them for the allocational bias. Hence, IPOs are underpriced to attract the uninformed investors. Benveniste and Spindt (1989) also assume that some investors such as institutional investors are better informed than the firm and the underwriter and argue that book-building results in institutional investors revealing their information.

the combined wealth change for insiders from the IPO through the SEO is positively related to insider retention at the IPO.

2.6. The changing issuer objective function model

Loughran and Ritter (2004) propose a model based on agency problems between the decision makers who comprise the top management and general partners of the lead venture capital firms and the other pre-IPO shareholders. The previous models assumed asymmetric information regarding the value of the firm whereas Loughran and Ritter (2004) assume that investors cannot observe the actions of the managers. First, the authors argue that managers are concerned with buying reputable analyst coverage. Hence, they hire a lead underwriter with a highly ranked analyst despite the fact that the underwriter has a reputation for underpricing. Cliff and Denis (2004) find support for this argument. Loughran and Ritter (2004) also suggest that co-lead managers are present in the syndicate to provide research coverage. This model predicts a positive relationship between IPO underpricing and both the underwriter ranking and the number of co-lead managers. Second, Loughran and Ritter (2004) argue that underwriters bribe the decision makers by allocating hot IPOs to their personal accounts to influence their choice of lead underwriter. Hence, insiders seek to maximize a weighted average of IPO proceeds, subsequent insider sales and side-payments from underwriters. While we cannot observe the amount of side-payments, their model implies a positive relationship between IPO underpricing and insider combined proceeds from the IPO and subsequent sales. Their model also implies a positive relationship between IPO underpricing and insider retention at the IPO as insiders prefer to sell subsequent to the IPO. We contend that the Loughran and Ritter's (2004) model also implies a positive relationship between insider retention and insider combined proceeds from the IPO and subsequent sales.

2.7. The information momentum model

Aggarwal et al. (2002) develop a model in which managers strategically underprice initial public offerings in order to create information momentum after the IPO, in the form of increased research coverage, so as to shift the demand curve for the stock upward. The information momentum will generate higher prices at the lockup expiration leading to the sale of insider shares at that time.[5] Their model shows that IPO underpricing will be positively related to insider retention of shares at the IPO. In addition, their model shows that IPO underpricing will be positively related, through the creation of information momentum, to insider sale of shares at lockup expiration. However, focusing exclusively on the lock-up expiration date is misleading. Brav and Gompers (2003) document that 60% of firms have insider sales before the lockup expiration date and Lee (1997) documents significant insider sales during SEOs. Hence, we extend the Aggarwal et al.

[5] The model proposed by Aggarwal et al. (2002) differs from the other models in this section, as they do not explicitly incorporate an informational advantage for one group. Aggarwal et al. (2002) assume that shares cannot be sold prior to lockup expiration; however, the underwriter may release the insiders from the lockup under certain conditions.

Table 1
Theoretical models and testable implications

Hypothesis	Testable implications	Theoretical model and source
1a	Positive relationship between IPO underpricing and underwriter rank	Changing objective function (Loughran and Ritter, 2004)
1b	Negative relationship between IPO underpricing and underwriter rank	Entrepreneurial losses (Habib and Ljungqvist, 2001)
2	Positive relationship between IPO underpricing and insider retention at IPO	Signaling (Grinblatt and Hwang, 1989) Entrepreneurial losses (Habib and Ljungqvist, 2001) Information momentum (Aggarwal et al., 2002) Changing objective function (Loughran and Ritter, 2004)
3	Positive relationship between IPO underpricing and uncertainty	Information production (Chemmanur, 1993) Entrepreneurial losses (Habib and Ljungqvist, 2001)
4	Negative relationship between IPO underpricing and IPO proceeds	Information production (Chemmanur, 1993)
5	Positive relationship between IPO underpricing and number of co-lead managers	Information momentum (Aggarwal et al., 2002) Changing objective function (Loughran and Ritter, 2004)
6	Positive relationship between IPO underpricing and the probability of SEO issuance	Signaling (Jegadeesh et al., 1993) Information production (Chemmanur, 1993) Market feedback (Jegadeesh et al., 1993)
7	Positive relationship between post-issue returns and the probability of SEO issuance	Market feedback (Jegadeesh et al., 1993)
8	Positive relationship between IPO underpricing and market response to the SEO filing	Signaling (Welch, 1989; Jegadeesh et al., 1993) Market feedback (Jegadeesh et al., 1993)
9	Positive relationship between post-issue returns and market response to the SEO filing	Market feedback (Jegadeesh et al., 1993)
10	Positive relationship between IPO underpricing and SEO proceeds	Signaling (Welch, 1989; Jegadeesh et al., 1993) Information production (Chemmanur, 1993) Market feedback (Jegadeesh et al., 1993)
11	Positive relationship between post-issue returns and SEO proceeds	Market feedback (Jegadeesh et al., 1993)
12	Positive relationship between IPO underpricing and firm combined proceeds	Signaling (Grinblatt and Hwang, 1989; Spiess and Pettway, 1997)

Table 1 (*continued*)

Hypothesis	Testable implications	Theoretical model and source
13	Positive relationship between insider retention at IPO and firm combined proceeds	Signaling (Spiess and Pettway, 1997)
14	Positive relationship between IPO underpricing and insider combined proceeds	Signaling (Spiess and Pettway, 1997) Information production (Chemmanur, 1993) Information momentum (Aggarwal et al., 2002) Changing objective function (Loughran and Ritter, 2004)
15	Positive relationship between insider retention at IPO and insider combined proceeds	Signaling (Spiess and Pettway, 1997) Entrepreneurial losses (Habib and Ljungqvist, 2001) Information momentum (Aggarwal et al., 2002) Changing objective function (Loughran and Ritter, 2004)
16	Positive relationship between research coverage (co-lead managers) and insider combined proceeds	Information momentum (Aggarwal et al., 2002)

(2002) model to include sales by insiders between the IPO and SEO and during the SEO. Specifically, we contend that insiders can maximize their wealth by selling shares before, during and after the lock-up expiration. Hence, the combined proceeds to insiders from the IPO and the subsequent period, including the SEO, are related to both IPO underpricing and insider retention at the IPO.

The Aggarwal et al. (2002) model focuses on the initiation of research coverage after the IPO and predicts a positive relationship between IPO underpricing and research coverage. Their model does not include a role for the underwriter. Bradley et al. (2003) show that there is a strong relation between the number of co-lead managers in the IPO and the subsequent initiation of research coverage. Thus, we extend the Aggarwal et al. (2002) model to predict a positive relationship between IPO underpricing and the number of co-lead managers in the IPO.

2.8. Summary of testable implications

In Table 1, we summarize the testable implications in the alternate form and show the links between the testable hypotheses and the underlying theoretical models.

1. Hypotheses 1 to 5 test the empirical implications that relate to the first stage of the financing (i.e. the IPO stage).
2. Hypotheses 6 to 9 test the empirical implications relating to the probability of SEO issuance and the market response to the SEO announcement.
3. Hypotheses 10 to 16 test the empirical implications for the firm and insiders in terms of the combined proceeds over the period from the IPO to the first SEO.

We test these hypotheses in a regression framework. While virtually all prior studies (with the exception of Habib and Ljungqvist, 2001) have conducted tests in an OLS framework, we provide 2SLS results that incorporate the endogeneity of underwriter selection and thus reduce the bias of the OLS estimates.

Since we test competing theoretical models, some of the hypotheses arise from multiple theories. Some of these theories may be derived from contradictory assumptions although they have common predictions.[6] Where models have common predictions, it is problematic to unambiguously support a specific theoretical model. Specifically, when the underlying theories are derived from contradictory assumptions, a significant result for the hypothesis test will not allow us to choose between the theories; hence, we can draw reliable inferences only by considering testable implications that are not shared by the models or that have opposite signs.[7,8]

In the next section, we describe our sample selection criteria.

3. Sample description

The primary data sources for this study are the Thomson Financial Securities Data (formerly Securities Data Company, SDC), new issues database and the Center for Research in Security Prices (CRSP) database. The sample selection criteria are detailed in Table 2. The initial sample is selected from the SDC database and consists of all U.S. publicly traded initial public offerings during the period 1991–1998. We then eliminate offerings consisting of closed-end funds, depository shares, mutual-to-stock conversions, partnerships, REITs, reverse LBOs, spin-offs and unit issues following recent studies such as Habib and Ljungqvist (2001) and Loughran and Ritter (2004). After eliminating firms that do not have data on CRSP, the selection criteria produces a sample of 3409 initial public offerings. We follow the methodology of Spiess and Pettway (1997) and Slovin et al. (1994) and eliminate financials (SIC code 6000–6999) and utilities (SIC code 4900–4999) since regulation may have different implications for equity issuance. To reduce the influence of low-priced stocks, we exclude firms with an offer price of less than $5.00 per share. We exclude firms that do not have firm and insider shareholding data during the IPO. The final IPO sample contains 2381 firms.

Next, we use the SDC database to identify firms that conduct the first seasoned equity offering within the first 36 months after the IPO. 979 firms meet this criterion in the period 1991 to 2001. Since we test the implication of the IPO underpricing signal at the seasoned equity issuance, we follow the sample selection approach used by Spiess and Pettway

[6] For example, hypothesis 6, a positive relationship between IPO underpricing and the probability of SEO issuance, arises from three theories. Two of these (the signaling and market feedback theories) rely on contradictory assumptions regarding who possesses superior information about the value of the firm.

[7] For example, the information production and market feedback theories imply hypotheses 6 and 10, but the market feedback theory is silent regarding hypotheses 3 and 4 and the information production theory is silent regarding hypotheses 7, 8, 9, and 11.

[8] Our research design is along the lines of papers such as Maxwell and Stephens (2003), Fama and French (2002), and Jung et al. (1996). These papers test competing models with contradictory assumptions that have some common predictions and some differing predictions.

Table 2
Sample selection

Number of IPOs issued in the period 1991 to 1998 with returns on the CRSP NYSE, AMEX, and Nasdaq database	3409
Less: Utilities and financial firms	(368)
Less: Firms with offer price less than $5	(90)
Less: Firms with missing data on firm or insider shareholdings at the IPO stage	(571)
Sample of IPO firms	2381
Number of firms with a first seasoned equity offering (within 3 years after the IPO) in the period 1991 to 2001	979
Less: Firms with missing data on firm or insider shareholdings at the SEO stage	(365)
Sample of SEO firms	514

The firms in the sample have stock price data available on CRSP and management (insider) shareholding data available in the Securities Data Company (SDC) Global New Securities database. Insiders are defined to be managers of the firm (SDC definition).

(1997) and Slovin et al. (1994). The window of 3 years between the IPO and SEO also was used by Spiess and Pettway (1997) and Michaely and Shaw (1994) and seems a reasonable period since our average firm returns to the market within a year of the IPO.

We exclude firms that do not have firm and insider shareholding data after the IPO and during the subsequent seasoned offering. We also exclude firms that do not have complete price data until the seasoned equity issuance. Our final sample consists of 514 pairs of equity offerings. We obtain the first-day closing market price, total shares outstanding, and daily stock returns data from the CRSP file for both the initial and seasoned equity offerings. The sample distribution by years of the offering is reported in Table 3. The number of seasoned equity offerings is higher in the second half of the sample, with the maximum number of seasoned offerings in 1996.

79.3% of the 2381 IPOs occurred on Nasdaq, 10.2% on the NYSE, and the remaining IPOs were spread over a number of markets. Among the 514 firms that issued SEOs,

Table 3
Sample distribution by years of offering of IPOs and first SEOs

IPO year	Year of first SEO											
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Total
1991	0	3	3	0								6
1992		13	44	5	3							65
1993			16	34	18	7						75
1994				6	44	25	2					77
1995					17	45	11	3				76
1996						25	63	22	2			112
1997							17	37	9	5		68
1998								6	25	4	0	35
Total	0	16	63	45	82	102	93	68	36	9	0	514

The sample includes industrial firms that conduct an IPO during the period 1991–1998 and a subsequent SEO within the first 36 months after the IPO. The firms in the sample have stock price data available on CRSP and management (insider) shareholding data available in the Securities Data Company (SDC) Global New Securities database. Insiders are defined to be managers of the firm (SDC definition).

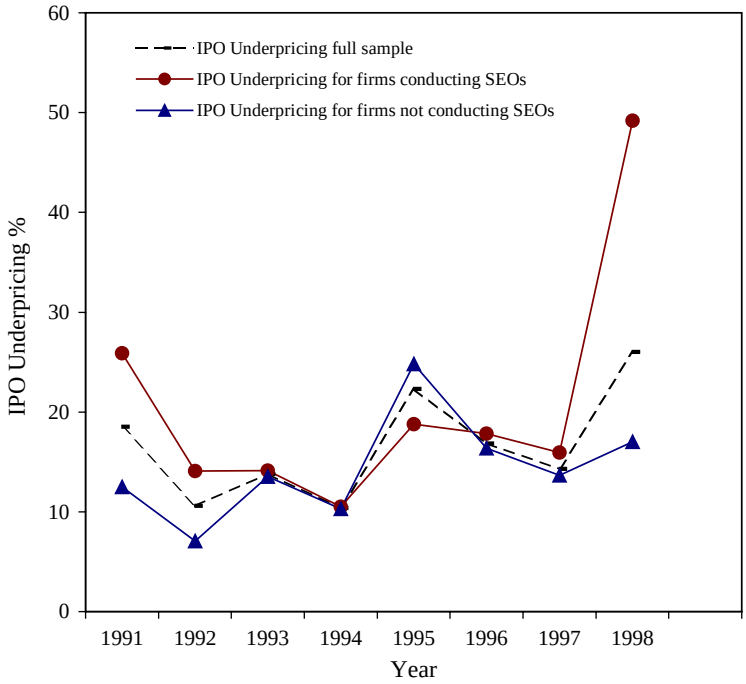

Fig. 1. IPO underpricing for the period 1991–1998.

87.3% of the IPOs occurred on Nasdaq, 9.2% on the NYSE, and the remaining IPOs were distributed across over other markets.

In Fig. 1, we plot the average IPO underpricing for the period 1991–1998. Underpricing was generally higher after 1994. In all the years except 1995, the underpricing for firms that issued SEOs was greater than that for firms that did not issue SEOs. The changes in IPO underpricing raise questions about potential changes in the IPO environment during the period.

Table 4 contains descriptions and data sources for the variables used in this study.

4. IPO underpricing

This section examines the first five hypotheses that relate to the IPO stage of financing. In Table 5, we provide the descriptive statistics for the 2381 firms that issued IPOs during the period 1991–1998. The average (median) first-day return is slightly over 16% (8%) and is comparable to studies such as Loughran and Ritter (2004), which have examined similar periods. The average amount of money left on the table is $7.82 million.[9] Slightly less than a third of the sample firms are from the high-tech sector and a little under half are

[9] Money on the table is defined as the first-day price change (offer price to close) multiplied by the number of shares issued (Loughran and Ritter, 2004).

Table 4
Description of variables and their data sources

Variable	Data sources	Description
First-day returns	SDC, CRSP	Percentage change from offer price (SDC) to closing price on first day of trading (CRSP).
Abnormal post-issue returns in days 2 to 20 (21 to 40)	CRSP	Cumulative excess returns (over the value weighted CRSP index return) for days 2 to 20 (21 to 40) after the IPO date. Expressed as percent (%).
Change in underwriter from IPO to SEO	SDC	Indicator variable =1 if underwriter is changed at the SEO.
Combined issue net proceeds/pre-IPO equity value	SDC/CRSP	Computed using Eq. (1).
Fraction of insider shareholdings before (after) the IPO (SEO); sold during IPO; sold in the period after the IPO and before the SEO	SDC	Insider shareholdings as a fraction of total shares. Insiders are defined to be managers of the firm. Expressed as percent (%).
Gross proceeds to the firm (insiders)	SDC	Offer price multiplied by the number of primary (secondary) shares sold. Insiders are defined to be managers of the firm (SDC definition). Expressed in $MM.
High-tech	SDC	Indicator variable =1 for firms with primary three-digit SIC codes of 357, 367, 369, 382, 384, and 737, else 0, following Field and Hanka (2001).
Lagged 15-day Nasdaq returns	CRSP	Return on the Nasdaq Composite Index for the 15 days before the IPO. Expressed as percent (%).
Ln(IPO proceeds)	SDC	Ln(IPO proceeds in millions).
Ln(days)		Ln(Number of trading days between the IPO and SEO).
Money left on table	SDC, CRSP	Product of shares issued (SDC) and change from offer price (SDC) to closing price on first day of trading (CRSP) (in millions).
Net SEO proceeds/pre-IPO equity value	SDC/CRSP	
Number of co-lead managers	SDC	Number of co-lead managers in the underwriting syndicate.
Price revision of offer price relative to original mid-filing price	SDC	Final offer price-midpoint of original filing range.
Positive price revision relative to original mid-filing price	SDC	Indicator variable =1 if price revision of offer price relative to midpoint of original filing price is positive, else 0.
Primary IPO (SEO)	SDC	Indicator variable =1 if issue has only primary offering, else 0.
Sigma	CRSP	Standard deviation of returns in days 2 to 20 after the IPO.
Underwriter rankings	Ritter	1 (worst) to 9 (best) scale for underwriter reputation. Underwriter rankings are the modified Carter and Manaster (1990), Carter et al. (1998) rankings and are obtained from J. Ritter's website http://bear.cba.ufl.edu/ritter/Rank.HTM.
Wealth change for insiders/pre-IPO equity value	SDC/CRSP	Computed using Eq. (2a).

Table 5
Descriptive statistics for IPOs

	Mean	Median
First-day returns (%)	16.02	8.33
Money left on the table ($ millions)	7.82	1.96
High-tech (%)	31.63	
Venture capital financed (%)	44.39	
Firms that have a positive price revision relative to original range (%)	37.00	
Abnormal post-issue returns in days 2–20 (%)	−2.45	−.60
Abnormal post-issue returns in days 21–40 (%)	−3.62	−1.30
Sigma	3.89	3.56
Gross proceeds to the firm ($ millions)	48.49	29.70
Gross proceeds to the insiders ($ millions)	7.37	0.00
Primary shares as percentage of offer	88.26	100.00
Fraction of insider shareholdings retained after the IPO (%)	44.67	46.40
IPO underwriter ranking	6.98	8.00
Number of co-managers	2.21	2.00

The sample includes 2381 industrial firms that conduct an IPO during the period 1991–1998. Please see Table 4 for a description of the variables.

financed by venture capitalists.[10] Abnormal post-issue returns in the short window (40 days) after the IPO are negative on average. We observe that the mean and median gross proceeds to the firm are $48.49 million and $29.70 million, respectively. The average (median) gross proceeds to the managers from sale of shares is $7.37 ($0) million. The average of insider shareholdings retained after the IPO is 45%. The median underwriter rank is high at 8 compared to the average of 6.98. The median firm has two co-lead managers including the lead manager.

Hypotheses 1 to 5 are tested in Table 6. We report the results of ordinary least squares (OLS) as well as two-stage least squares (2SLS) regressions with IPO underpricing as the dependent variable. Standard errors are reported in parentheses and are adjusted for heteroscedasticity using White's (1980) heteroscedastic-consistent covariance matrix. The predicted signs for the variables in Table 6 are based on the various hypotheses.

In addition to the explanatory variables to test the various hypotheses, we also include control variables in the multiple regression specification based on prior studies. Ljungqvist and Wilhelm (2003) contend that there will be greater underpricing for pure primary offerings since the extent to which insiders care about underpricing depends on how much they sell at the IPO. The fewer shares managers sell, the lesser their incentive to decrease underpricing, so we include an indicator variable that has a value of 1 if the offering is a pure primary offering. We include the lagged 15-trading-day return on the Nasdaq

[10] We adopt the classification scheme used by Field and Hanka (2001). High-tech firms are those with primary three-digit SIC codes of 357, 367, 369, 382, 384, and 737. These industries are computer and office equipment (SIC code 357), electronic components and accessories (367), miscellaneous electrical machinery, equipment, and supplies (369), laboratory apparatus and analytical, optical, measuring, and controlling instruments (382), surgical, medical, and dental instruments and supplies (384), and computer programming, data processing, and other computer related (737).

Table 6
IPO underpricing

		OLS (Model 1)	2SLS (Model 2)	
	Predicted signs	First-day returns	Underwriter ranking	First-day returns
Constant		.1367*** (.0281)	1.4794*** (.1626)	.1735*** (.0312)
IPO underwriter rank	+/−	.0086 (.0030)		−.0148*** (.0047)
Fraction of insider shareholdings retained after the IPO	+	.0615** (.0275)	.0304 (.1554)	.0757*** (.0247)
Fraction of insider shareholdings sold during the IPO	−	−.0733* (.0402)		−.1294*** (.0411)
High-tech firm	+	.0524*** (.0138)	.3044*** (.0712)	.0587*** (.0107)
Ln(IPO proceeds)	−	−.0372*** (.0078)	1.6820*** (.0372)	
Number of co-lead managers	+	.0115* (.0062)		.0154** (.0071)
Primary IPO		.0248** (.0103)	−.4523*** (.0683)	.0120 (.0110)
Lagged 15-day Nasdaq returns		.0040*** (.0014)		.0041*** (.0011)
Price revision of offer price relative to original mid-filing price		.5379*** (.0463)		.4903*** (.0360)
Positive price revision relative to original mid-filing price		.0459*** (.0132)		.0553*** (.0155)
Adjusted R^2		.2426	.4936	.2247

The sample includes 2381 industrial firms that conduct an IPO during the period 1991–1998. The dependent variable is the IPO first-day return. The variables are described in Table 4. Standard errors are reported in parentheses and are adjusted for heteroscedasticity using White's (1980) heteroscedastic-consistent covariance matrix. *, **, or *** denotes significance at the 10%, 5%, or 1% level for two-tailed tests.

Composite index since studies (e.g. Loughran and Ritter, 2004 and Lowry and Schwert, 2004) have shown that first-day returns can be predicted based on prior market returns. Hanley (1993) documented that underpricing is positively associated with the revision of the offer price above the midpoint of the filing range. This is known as the partial adjustment effect. In order to control for it, we add a variable measuring revisions in the final offer price relative to the midpoint of the original filing range as well as an indicator variable if the price revision was positive.

We consider model 1, the OLS specification, first. Hypothesis 1 is not supported as the underwriter rank is not significant. Hypothesis 2 is supported as underpricing is positively correlated with retained insider shareholdings and negatively correlated with the fraction of insider shareholdings sold during the IPO. This suggests that the extent to which insiders care about underpricing depends on how much they sell at the IPO. This result is consistent with signaling theory, the entrepreneurial losses model, the information momentum model, and the changing objective function model. The coefficient for high-tech is positive and significant, supporting hypothesis 3. This is consistent with the prediction of the information production model and the entrepreneurial losses model that firms with projects that are costlier to evaluate will have greater underpricing. Hypothesis 4 is supported since the sign on the variable Ln(gross proceeds) is negative and significant. This result is consistent with the information production

model. Hypothesis 5 is supported since the number of co-lead managers is positively correlated with underpricing, consistent with the information momentum and changing objective function models. The signs of the coefficient estimates for the control variables are consistent with prior studies.

The OLS regression ignores the endogeneity of the underwriter choice, which could lead to biased OLS coefficients. Previous studies have used the OLS approach, a prominent exception being Habib and Ljungqvist (2001). We therefore control for the simultaneity of the underwriter choice and estimate the system using a two-stage least squares (2SLS) framework. These results are reported in model 2 of Table 6. The first stage estimates the underwriter rank, while the second stage uses the predicted rank as an instrumental variable in the underpricing regression.[11] While the results for models 1 and 2 are qualitatively similar, the major change is with respect to the association between IPO underpricing and underwriter rank. We now find that the coefficient estimated for rank is negative and significant, indicating that the more prestigious the underwriter the lesser the underpricing. This result is consistent with the entrepreneurial losses model (hypothesis 1b). It contradicts the changing objective function model (hypothesis 1a) that issuers hire a lead underwriter with a highly ranked analyst to buy analyst coverage despite the fact that the underwriter has a reputation for underpricing.

Overall, our analysis at the IPO stage provides support for signaling theory and the information production, entrepreneurial losses and information momentum models. In the next section, we examine hypotheses 6 through 9 related to the probability of issuance of a seasoned equity offering and the market response to the SEO announcement.

5. Seasoned equity issue

5.1. Probability of issuance of an SEO

We now test hypotheses 6 and 7 that the probability of a seasoned equity issuance is positively associated with IPO underpricing as well as post-issue returns. We present the logit regression estimates in Table 7. We also present the marginal impact in the adjacent column. The marginal impact represents the change in the probability of issuing seasoned equity given a unit change in the independent variable if it is continuous. For indicator variables, the marginal impact is the difference in probability when the variable equals 1 versus 0, evaluated at the means of the other variables.

The coefficient estimate on IPO underpricing is positive and significant which is consistent with the signaling model, the information production model, and the market feedback model. The coefficient estimates for post-issue returns are positive and significant for both periods. This result is consistent with the market feedback model. The marginal impact analysis indicates that the post-issue returns have a stronger association with the likelihood of a seasoned equity issuance than IPO underpricing. The

[11] The variable Ln(IPO proceeds) is excluded from the underpricing model to avoid identification issues.

Table 7
The probability of SEO issuance

	Predicted sign	Model	Marginal impact
Constant		−2.2028*** (.3114)	−2.1374*** (.3044)
First-day returns	+	.4319** (.2173)	.3890** (.1934)
Abnormal post-issue returns in days 2–20 after the IPO	+	.9769*** (.2735)	.9787*** (.2731)
Abnormal post-issue returns in days 21–40 after the IPO	+	1.8302*** (.2735)	1.8238*** (.2729)
High-tech firm		.0005 (.1180)	−.0119 (.1175)
Primary IPO		.0011 (.1083)	.0093 (.1067)
Fraction of insider shareholdings retained after the IPO		.3966 (.2598)	.3931 (.2567)
Fraction of insider shareholdings sold during the IPO		−.6031 (.4466)	−.5900 (.4452)
Sigma		−.6910 (2.8660)	−.7063 (2.8609)
Ln(IPO proceeds)		−.0027 (.0842)	−.0102 (.0799)
IPO underwriter rank		.0916** (.0356)	.0998*** (.0350)
Price revision of offer price relative to original mid-filing price		−.5419 (.3922)	
Positive price revision relative to original mid-filing price		.2463 (.1571)	
Adjusted R^2		.0400	.0392

The sample includes 2381 industrial firms that conduct an IPO during the period 1991–1998. 514 of these firms conducted an SEO within the first 36 months after the IPO. The dependent variable is an indicator variable that takes a value of 1 if the firm issued an SEO and 0 otherwise. The variables are described in Table 4. Standard errors are reported in parentheses and are adjusted for heteroscedasticity using White's (1980) heteroscedastic-consistent covariance matrix. *, **, or *** denotes significance at the 10%, 5%, or 1% level for two-tailed tests.

results support the market feedback model because the signaling model and the information production model only consider first-day returns and ignore post-issue returns. Next, we examine the market reaction to the announcement of a seasoned equity issuance.

5.2. Share price reactions to seasoned equity announcements

We begin by examining the magnitude of the share price reaction around the Wall Street Journal (WSJ) announcement of seasoned equity offerings. Share-price reactions in a time-window are measured by calculating cumulative excess returns, where excess return is the difference between the SEO firm's return and the CRSP value-weighted index return. The WSJ announcement date is $t=0$. As reported in Table 8, the average (median) excess return on the announcement date is −1.59% (−1.62%), statistically significant at the 1% level. About a third of the firms that announce seasoned equity issues are high-tech. The average excess return on the announcement date is negative and significant at the 1% level for both high-tech and non-high-tech firms. However, for high-tech firms the average excess return is less negative compared to non-high-tech firms on the announcement date, although the difference is not statistically significant.

Table 8
Excess returns around the Wall Street Journal announcement for first SEO issue subsequent to an IPO

Event period interval	All SEOs		High-tech		Non-high-tech		*t*-test for difference of means (*p*-values for two-sided tests)	Wilcoxon's rank sum test for medians (*p*-values for two-sided tests)
	Mean	Median	Mean	Median	Mean	Median		
(0)	−.0159***	−.0162***	−.0144***	−.0154***	−.0166***	−.0162***	.6260	.7331
(−1, 0)	−.0168***	−.0178***	−.0127**	−.0176***	−.0188***	−.0178***	.2865	.6969
(−1, 1)	−.0237***	−.0268***	−.0211***	−.0375***	−.0251***	−.0253***	.5733	.5784
Number of SEOs	514		170		344			

The sample includes 514 industrial firms that conduct an SEO within the first 36 months after the IPO. The sample period is 1991–2001. Excess return is the difference between the SEO firm's return and the CRSP value-weighted index return. Returns are calculated from close to close. The WSJ announcement date is deemed as $t=0$. *, **, and *** denote that the mean or median is significantly different from 0 at the 10%, 5%, and 1% level.

For a 2-day (−1 to 0) window around the announcement date, the average excess return is −1.68%. This is lower (in absolute value) than the 2-day (−1 to 0) excess return of −2.87% reported by Slovin et al. (1994) for Nasdaq firms for the period 1973–1988.

We use cross-sectional regressions to examine hypotheses 8 and 9 regarding the relationship between the SEO announcement date market response and IPO underpricing and the post-issue returns. We follow an approach similar to Slovin et al. (1994). Table 9 presents results for two regression models with the dependent variable being the 2-day ($t=-1$ to 0) excess returns on the first SEO announcement date. Standard errors have been adjusted for heteroscedasticity using White's (1980) heteroscedastic-consistent covariance matrix.

The independent variables follow from our hypotheses and from previous studies. The variables of interest are IPO first-day return and post-issue returns. Following Slovin et al. (1994), our control variables include the fraction of retained insider holdings after the IPO, the fraction of the firm's outstanding shares sold by insiders after the IPO and before the first SEO,[12] an indicator variable that equals 1 if the SEO contains only primary shares, the natural logarithm of the number of days between the IPO and the first SEO, the post-issue standard deviation of returns following the IPO (measured over trading days 2 to 20), and the size of the IPO. Since there was a notable increase in high-tech issues in the late 1990s, specifically after 1997, we also include an indicator variable for high-tech firms. We control for underwriter by including the underwriter rank at the IPO and an indicator variable for change in underwriter.

Model 1 in Table 9 includes the variable for insider retention after the IPO while model 2 includes the variable for insider sales subsequent to the IPO. The variables for insider retention and insider sales subsequent to the IPO are highly correlated and so they cannot be included in a single model. We find that the coefficient estimate on IPO underpricing is positive and significant while the coefficient estimates on the abnormal post-issue returns are positive but not significant.[13] These results are consistent with the signaling model and inconsistent with the market feedback model, which predicted a significant relationship with the post-issue returns. These results are surprising in view of the strong support that we found for the market feedback hypothesis in the logit analysis. The number of days between the IPO and SEO is positive and significant, suggesting that the market reacts more positively if the firm takes longer to make its first seasoned offering. This result is inconsistent with Slovin et al. (1994) where their time variable, measured as 1/number of days, was not significant. The coefficient estimate for Ln(IPO proceeds) is positive and weakly significant in model 2 and the remaining control variables are not significant.

The results in this section provide support for the signaling model as the first-day return is significantly related to the probability of SEO issuance and the market's response to the SEO announcement. The results are mixed for the market feedback model as post-issue

[12] We use insider sales after the first IPO and before the first SEO because Brav and Gompers (2003) show that 60% of firms have insider sales prior to the lock-up expiration date.

[13] The result for the IPO first-day return is consistent with Slovin et al. (1994).

Table 9
Market reaction to WSJ announcement of the SEO

	Predicted sign	Two-day excess returns ($t=-1, 0$) about the SEO nnouncement date	
		Model 1	Model 2
Constant		−.1183*** (.0431)	−.1361*** (.0426)
IPO first-day return	+	.0241* (.0126)	.0242** (.0121)
Abnormal post-issue returns in days 2–20 after the IPO	+	.0209 (.0275)	.0210 (.0273)
Abnormal post-issue returns in days 21–40 after the IPO	+	.0085 (.0158)	.0097 (.0158)
Fraction of insider shareholdings retained after the IPO		−.0063 (.0127)	
Fraction of firm's outstanding shares sold by insiders after the IPO and before the first SEO			−.0374* (.0209)
Ln(days)		.0129** (.0058)	.0153*** (.0092)
Sigma		−.0043 (.2311)	.0246 (.2344)
Ln(IPO proceeds)		.0083 (.0050)	.0090* (.0050)
High-tech firm		.0049 (.0060)	.0059 (.0061)
Primary SEO		−.0007 (.0065)	−.0003 (.0065)
IPO underwriter rank		−.0011 (.0022)	.0011 (.0022)
Change in underwriter IPO to SEO		.0064 (.0062)	.0061 (.0061)
Adjusted R^2		.0378	.0424

The sample includes 514 industrial firms that conduct an SEO within the first 36 months after the IPO. The sample period is 1991–2001. The variables are described in Table 4. Standard errors are reported in parentheses and are adjusted for heteroscedasticity using White's (1980) heteroscedastic-consistent covariance matrix. *, **, or *** denotes significance at the 10%, 5%, or 1% level. Significance levels are based on two-sided tests for all variables.

returns are related to the probability of SEO issuance but not related to the market response to the SEO announcement.

6. Equity offering pairs—combined proceeds for the firm and changes in insider wealth

Spiess and Pettway (1997) provide a detailed analysis of the effects of IPO underpricing on the combined net proceeds from the IPO and first SEO. They examine both the combined net proceeds for the firm and the wealth changes for insiders. The calculation of these measures is shown in Appendix A. Spiess and Pettway (1997) used a sample of 172 firms, which had IPOs during 1987–1991. Our analysis is similar but uses a much larger sample of more recent IPOs.

Descriptive statistics are provided in Table 10. The statistics in Panels A and B can be compared to Table 3 of Spiess and Pettway (1997) and Panel C can be compared to Table 2 of Spiess and Pettway (1997).

From panel A, we observe that the issues in our sample tend to be larger; our average IPO net proceeds of $38.33 million are approximately a third higher than that of Spiess and Pettway (1997). Similarly, our mean SEO net proceeds are $65.82 million, more than 166% of the value observed by Spiess and Pettway (1997). The average combined net

Table 10
Combined equity issue proceeds and insider shareholder wealth change measures

	Mean	Median
Panel A: issue net proceeds		
IPO net proceeds ($ millions)	38.33	29.80
SEO net proceeds ($ millions)	65.82	49.50
Combined net proceeds ($ millions)	102.72	81.27
IPO net proceeds (% of pre-IPO equity value)	33.13	29.39
SEO net proceeds (% of pre-IPO equity value)	63.94	49.58
Combined net proceeds (% of pre-IPO equity value)	97.08	80.91
Panel B: wealth change measures for insiders		
IPO wealth change ($ millions)	−6.87	−2.23
SEO wealth change ($ millions)	160.60	44.44
Combined wealth change ($ millions)	153.73	40.61
IPO wealth change (% of pre-IPO equity value)	−3.81	−2.62
SEO wealth change (% of pre-IPO equity value)	77.79	47.81
Combined wealth change (% of pre-IPO equity value)	73.97	44.33
Panel C: other information		
IPO first-day return (%)	19.14	11.36
Money left on the table at the IPO ($ millions)	9.22	3.09
Stock price appreciation between IPO and SEO (%)	70.31	78.75
Calendar days between IPO and SEO	383	318
Fraction of insider shareholdings retained before the IPO (%)	65.15	68.22
Fraction of insider shareholdings retained after the IPO (%)	45.78	48.45
Fraction of insider shareholdings retained before the SEO (%)	39.52	40.45
Fraction of insider shareholdings retained after the SEO (%)	29.91	29.65

The sample includes 514 industrial firms that conduct an SEO within the first 36 months after the IPO. The sample period is 1991–2001. The issue-combined proceeds measured in panel A are computed using Eq. (1); the wealth change measure in panel B is computed using Eq. (2a) for insiders. Each equation is evaluated at a zero discount rate. The pre-IPO equity value is the number of shares outstanding prior to the IPO (N_0) multiplied by the true price (P^*).

proceeds (as a percentage of the pre-IPO equity value) are 97% in our sample versus 65.7% in their sample.

From panel B, we observe that our measures of wealth change for insiders are also much bigger. For the average (median) firm, the insiders gave up $6.87 (2.23) million at the IPO and received $160.63 (44.44) million at the first SEO. The corresponding figures for Spiess and Pettway's sample are $1.9 (0.5) million and $33.7 (12.8) million, respectively. The average value of the insiders' wealth change (as a percentage of the pre-IPO equity) is about 73.97% in our sample and 54.8% in their sample.

In Panel C we observe that the average IPO underpricing for these 514 firms is 19% compared to 16% for the full sample of 2,381 firms (see Table 5) and 10% for the Spiess and Pettway (1997) sample. Similarly the average money left on the table of $9.22 million is higher than the $7.82 million for the full sample reported in Table 5. On average, the firms returned to the market for a seasoned equity offering in a little over a year. This is longer than the gap for the Spiess and Pettway (1997) sample. The

sample firms appreciated by 70% on average, in the interim period after the IPO and prior to the seasoned offering. These results are consistent with the findings of Spiess and Pettway (1997) and Slovin et al. (1994). Regarding the insider shareholdings, one caveat worthy of mention is that we use the SDC definition of managers as insiders, whereas Spiess and Pettway's (1997) calculations are based on the criterion of officers and directors as insiders. On average, the change in insider holdings during the IPO is 19%. Insiders retain an average of 45.78% after the IPO, slightly higher compared to 41.6% for Spiess and Pettway's (1997) sample. The change in insider holdings during the seasoned equity offering is about 10%, which is higher than the 4% reported by Spiess and Pettway (1997). It also appears that insider holdings have on average decreased by 6% in the period between the IPO and the SEO, similar to Spiess and Pettway (1997). Insiders retain an average of 29.91% after the SEO. Although our results are consistent with Slovin et al. (1994) that firms still have high insider ownership even after the first seasoned equity issuance, insiders have reduced their pre-IPO holdings by approximately 40% by the time the firm returns to the market for the first seasoned offer.

We now present the results of the tests of hypotheses 10 to 16. Table 11 presents results for various regression models with three dependent variables: the SEO proceeds normalized by pre-IPO equity value, the combined issue net proceeds (as a percentage of pre-IPO equity value) and the wealth change for insiders (as a percentage of pre-IPO equity value). The variables of interest are the IPO first-day return, post-issue returns, the fraction of retained insider holdings after the IPO, and the number of co-lead managers. Following Spiess and Pettway (1997), we use the natural logarithm of the number of days between the IPO and the first SEO, the post-issue standard deviation of returns following the IPO, and the size of the IPO as control variables. In addition, we include indicator variables for high-tech firms and firms that issued pure primary offers during the IPO. In order to control for Hanley's (1993) partial adjustment effect, we add an indicator variable that takes a value of 1 if the IPO offer price is greater than the high end of the filing range. Finally, we also control for underwriter quality.

In model 1, the dependent variable is the SEO proceeds normalized by pre-IPO equity value. This model is used to test hypotheses 10 and 11. We find that the seasoned equity proceeds received by the firm are negatively related to IPO underpricing, indicating that firms are worse off with underpricing. These results are inconsistent with the signaling, information production and market feedback models. The coefficient estimates on post-issue returns are not significant over the complete sample. This result provides weak support for the market feedback model. Among the control variables, there is a significant negative relationship between SEO proceeds and insider retention at the IPO, size of the IPO, and underwriter rank, while there is a positive relationship with the number of days between the IPO and SEO proceeds.

In model 2, we report the results of the OLS regression where the dependent variable is the combined firm net proceeds (as a percentage of pre-IPO equity value). Hypotheses 12 and 13 are tested with this model. Contrary to the central prediction of the signaling model, the coefficient on IPO underpricing is negative and significant. This is consistent with the findings of Spiess and Pettway (1997) that IPO underpricing makes firms worse. As in Spiess and Pettway (1997), the coefficient on insider retention is negative, a finding

Table 11
Regression estimates: IPO and first seasoned equity sale-combined issue proceeds, net SEO proceeds and insider wealth changes

	Predicted sign	OLS	OLS		2SLS			
		Model 1	Model 2	Model 3	Model 4		Model 5	
		Net SEO proceeds/pre-IPO equity value	Combined issue net proceeds/pre-IPO equity value	Wealth change for Insiders/pre-IPO equity value	Underwriter ranking	Combined issue net proceeds/pre-IPO equity value	Underwriter ranking	Wealth change for Insiders/pre-IPO equity value
Constant		.6293 (.3039)	.5666 (.3521)	−2.2852*** (.7665)	2.2659*** (.3425)	1.4005*** (.4702)	2.2659*** (.3425)	−2.2052 (.7514)
IPO first-day return	+	−.1564* (.0904)	−.2802** (.1366)	.0497 (.3482)		−.2758*** (.0966)		.0617 (.1543)
Abnormal post-issue return in days 2 to 20	+	.1275 (.1422)	.0627 (.1794)	.0647 (.3303)		.0722 (.1506)		.0545 (.2407)
Abnormal returns in days 21 to 40	+	.3119 (.2514)	.2643 (.3027)	.6087 (.3747)		.2963* (.1669)		.5913** (.2667)
Fraction of insider shareholdings retained after the IPO	+	−.2859*** (.1015)	−.4462*** (.1228)	.9748*** (.2777)		−.5084*** (.1435)		.9694*** (.2293)
Number of co-lead managers	+	.1182*** (.0291)	.0729** (.0292)	.2097*** (.0700)		.1198*** (.0323)		.2134*** (.0517)
Ln(days)		.1251*** (.0465)	.1806*** (.0554)	.2428** (.0881)		.1323** (.0586)		2416** (.0936)
Sigma		2.0326 (1.8711)	3.1765 (2.3686)	14.3332** (5.5695)		2.5499 (1.5616)		15.4637*** (2.4955)
Ln(IPO proceeds)		−.1768*** (.0396)			1.4260*** (.0878)		1.4260*** (.0878)	
High-tech firm		−.0322 (.0657)	−.0860 (.0781)	.1514 (.1215)	.4163*** (.1388)		.4163*** (.1388)	
Primary IPO	+				.0195 (.1333)		.0195 (.1333)	
Positive price revision relative to original mid-filing price	+	−.0305 (.0525)	−.1200* (.0632)	−.1884 (.1177)		−.0608 (.0661)		−.1785* (.1057)
IPO Underwriter Rank	+	−.0489*** (.0181)	−.0890*** (.0200)	−.0023 (.0244)		−.1832*** (.0354)		−.0134 (.0565)
Adjusted R^2		.1750	.1628	.1872	.3516	.1090	.3516	.1835

The sample includes 514 industrial firms that conduct an SEO within the first 36 months after the IPO. The sample period is 1991–2001. The combined issue net proceeds are computed using Eq. (1); the wealth change measure for insiders is computed using Eq. (2a). Each equation is evaluated at a zero discount rate (the results remain unchanged for annual discount rates ranging from 0 to 8%). The pre-IPO equity value is the number of shares outstanding prior to the IPO (N_0) multiplied by the true price (P^*). The other variables are described in Table 4. Robust standard errors are reported in parentheses. *, **, or *** denotes significance at the 10%, 5%, or 1% level. Significance levels are based on two-sided tests for all variables.

inconsistent with the signaling model. Moreover, in our sample, the coefficient estimate is statistically significant. We also find that firms do not seem to benefit from the partial adjustment of the IPO offer price, since the coefficient on the revision variable is negative and significant. The association with the other variables is similar to the results reported for SEO proceeds in model 1.

The dependent variable in model 3 is the combined insider wealth changes (as a percentage of pre-IPO equity value), allowing us to test hypotheses 14, 15, and 16. The coefficient estimate on IPO underpricing is positive but not significant, while the coefficient estimate for insider retention subsequent to the IPO is positive and significant. These results differ from Spiess and Pettway (1997) who find that IPO underpricing is negative and weakly significant and insider retention is not significant. The coefficient for the number of co-lead managers is positive and significant. Among the control variables, the length of time between the IPO and the SEO, the post-issue standard deviation of returns have positive associations with insider wealth change. The IPO underwriter rank is insignificant after being significantly negative for the models looking at firm proceeds. Our adjusted R-squared of about 0.17 is dramatically higher than those reported by Spiess and Pettway (their maximum adjusted R^2 is 0.007 for these types of models).

The OLS analysis in models 2 and 3 ignores the endogeneity of the financing decision and the underwriter choice. To consider this potential simultaneity, we estimate the underwriter rankings and firm proceeds in a two-stage least squares regression (2SLS) framework in model 4. We perform a similar analysis for insider wealth changes and underwriter ranking in model 5. The specification for models 4 and 5 are different from models 2 and 3 to avoid identification problems during estimation.

The results for the combined firm net proceeds are consistent between models 2 and 4 as the coefficients for IPO first-day returns (hypothesis 12) and insider retention at the IPO (hypothesis 13) are negative and significant.

The results for the combined insider wealth change in model 5 are similar to our findings in model 3 with two changes. In contrast to model 3, we find that the coefficient estimate for the indicator variable for positive revision from the IPO offer price is negative and significant. We also find that the coefficient for abnormal returns in days 21 to 40 after the IPO is significant. Overall, our results relating to changes in insider wealth indicate that insiders adopt strategies in the IPO process consistent with wealth-maximizing behavior.

The results for the firm combined proceeds in models 2 and 4 are inconsistent with hypotheses 12 and 13. The hypotheses predict a positive relationship for IPO first-day returns and insider retention at the IPO but a significant negative relationship was observed. This result is inconsistent with signaling theory.

The results for insider wealth change are mixed. The coefficient for IPO first-day returns (hypothesis 14) is positive but not significant. However, the coefficient for insider retention at the IPO is significantly positive in accordance with hypothesis 15 and the coefficient for number of co-lead managers is significantly positive in accordance with hypothesis 16. Thus, the only model without support is the market feedback model, while the other models have limited support.

Our analysis of equity pairs suggests that firms are worse off due to underpricing. Firms do not appear to recover the cost of an underpriced IPO in the first SEO. However, the changes in insider wealth suggest that insiders appear to be minimizing their underpricing-related losses.[14]

7. Summary and conclusions

We summarize our findings in Table 12. In panel A, the rows list the hypotheses and the columns list the six underlying models. Within the cells, the top row shows the predicted sign from Table 1. The information in parentheses in the second row of the cell indicates the results (the sign and significance levels) from the analysis in Sections 4–6. The results must be interpreted carefully as hypotheses may be derived from multiple theories; for example, hypotheses 2, 14, and 15 are derived from four theories. Hypotheses that are not common to the models are highlighted, as findings related to these hypotheses offer the most reliable inferences. In panel B, we summarize the findings from panel A. In rows two to four, information relating to the hypotheses that are unique to a model are noted in parentheses.

The entrepreneurial losses model is very strongly supported as the results are consistent for all hypotheses derived from the model. Insiders appear to focus on their overall wealth, considering both the IPO and subsequent share sales and holdings, and minimizing the impact of IPO underpricing by retaining their shares at the IPO. The results are also strongly supportive of the information momentum model.

However, the results are not as supportive for the information production model since the findings are significant but in the opposite direction for hypothesis 10, IPO underpricing and SEO proceeds. The results are less convincing for the market feedback model since two of the unique hypotheses are not supported. The changing objective function model does not do as well either, since its unique implication, hypothesis 1 is not supported.

The signaling models seem least convincing. Hypotheses 10, 12, and 13 resulted in coefficients that are significant with the opposite sign to the prediction from the signaling model. The coefficients are consistent with the signaling model for the other four hypotheses (2, 6, 8, 15) but in all four cases, the hypotheses also are derived from other theories. For example, hypotheses 2 and 15 are derived from the entrepreneurial losses and information momentum models as well as the signaling model.

These findings may be of interest to financial managers and investors. From the viewpoint of the firm, underpricing is not an effective signal. Our results indicate that firms are leaving money on the table during the IPO and do not appear to recover these costs at least by the first SEO. For the investor, our results point to an agency problem since the insiders appear to be taking care of themselves by timing their sales to maximize

[14] As noted by a referee, our analysis implicitly assumes stationarity during our sample period. We repeated the analysis for the sub-periods 1991–1994 and 1995–1998 and find the results are mainly consistent with that for the full sample period. We also repeated our analysis for hot and cold markets based on the classification adopted by Helwege and Liang (2004) and find that the results are robust to this classification.

Table 12
Summary of results

Testable implications		Signaling	Information production	Market feedback	Entrepreneurial losses	Changing objective function	Information momentum
Panel A: testable implications and results							
1	IPO underpricing and underwriter rank				– (–***)	+ (–***)	
2	IPO underpricing and insider retention at IPO	+ (+***)			+ (+***)	+ (+***)	+ (+***)
3	IPO underpricing and uncertainty		+ (+***)		+ (+***)		
4	IPO underpricing and IPO proceeds		– (–***)				
5	IPO underpricing and number of co-lead managers					+ (+**)	+ (+**)
6	IPO underpricing and probability of SEO issuance	+ (+**)	+ (+**)	+ (+**)			
7	Post-issue returns and probability of SEO issuance			+ (+***)			
8	IPO underpricing and SEO market response	+ (+**)		+ (+**)			
9	Post-issue returns and SEO market response			+ (+)			
10	IPO underpricing and SEO proceeds	+ (–*)	+ (–*)	+ (–*)			

11	Post-issue returns and SEO proceeds			+ (+)			
12	IPO underpricing and firm combined proceeds	+ (–***)					
13	Insider retention at IPO and firm combined proceeds	+ (–***)					
14	IPO underpricing and insider combined proceeds	+ (+)	+ (+)			+ (+)	+ (+)
15	Insider retention at IPO and insider combined proceeds	+ (+***)			+ (+***)	+ (+***)	+ (+***)
16	Insider combined proceeds and research coverage						+ (+***)
Panel B: summary							
Significant findings consistent with hypotheses (hypotheses not shared with other models in parentheses)		4	3 (1)	3 (1)	4 (1)	3	4 (1)
Significant findings inconsistent with hypothesis (hypotheses not shared with other models in parentheses)		3 (2)	1	1	0	1 (1)	0
Insignificant findings (hypotheses not shared with other models in parentheses)		1	1	2 (2)	0	1	1
Total		8	5	6	4	5	5

This table is an extension of Table 1. In panel A, each cell has the predicted sign for the testable implication as in Table 1. We report the results (sign and significance level of the coefficient estimate) from the analysis in Sections 4–6, in parentheses. Where applicable, 2SLS results have been reported. The unique hypotheses for each model have been highlighted in panel A. *, **, or *** denote significance at the 10%, 5%, or 1% level.

their wealth. They retain their shares at the IPO and as a result, appear to have limited concerns about IPO underpricing. Alternatively, they incur costs (e.g. by buying analyst coverage) to encourage information generation prior to the IPO and after the IPO. The information production generates higher prices leading to insiders selling their shares at that time and thereby minimizing their underpricing losses.

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Appendix A

Following Spiess and Pettway (1997), the expected present value of the total cash proceeds from the IPO and SEO is calculated as:

$$N_{p1}\left(P^{*}-D-f_{p1}\right)+N_{p2}\left(P_{2}-f_{p2}\right)e^{-rt} \tag{1}$$

where,

N_0 = number of shares in the firm before the IPO,
N_{p1} = number of primary shares sold at the IPO,
N_{p2} = number of primary shares sold at the SEO,
P_1 = offer price per share for the IPO,
P_1^c = post-IPO closing market price per share,
P^* = the true market value per share of the IPO,
$= P_1^c + \frac{N_{p1}}{N_0}\left(P_1^c - P_1\right)$,
D = underpricing (in dollars) per share at the IPO = P^* - P_1,
P_2 = offer price per share for the SEO,
f_{p1} = underwriting spread (per share) plus selling costs for the IPO,
f_{p2} = underwriting spread (per share) plus selling costs for the SEO,
r = continuously compounded interest rate, and
t = time between the initial and seasoned equity offerings.

The present value of the wealth change for insiders is calculated as:

$$\Delta W_1 + \Delta W_2 e^{-rt}, \tag{2a}$$

where ΔW_1 is the insider's wealth change from the IPO and ΔW_2 is the insider's wealth change from the SEO.

The insider's wealth change from the IPO is calculated as:

$$\Delta W_1 = N_{s1}\left(P^* - D - f_{p1}\right) + \left(N_0 - N_{s1}\right)P_1^c - N_0 P^* \tag{2b}$$

and the wealth change at the SEO is:

$$\Delta W_2 = N_{s3}\left(P_2 - f_{p2}\right) + N_{s2}\left(P_{12}\right) + N_{sf}\left(P_2\right) - \left(N_0 - N_{s1}\right)P_1^c \tag{2c}$$

where,

N_{s1} = number of shares sold by the insiders at the IPO,
N_{s2} = number of shares sold by the insiders after the IPO and before the SEO,
N_{s3} = number of shares sold by the insiders at the SEO,
N_{sf} = number of shares owned by the insiders after the SEO,
P_{12} = average stock price in the period between the IPO and SEO.

Eq. (2c) assumes that any insider sales after the IPO and until the SEO are made at the average of the stock price (adjusted for stock splits) between the IPO and SEO.

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