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Strategic IPO underpricing, information momentum, and lockup expiration selling ☆

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Abstract

Managers usually do not sell any of their own shares in an initial public offering but instead wait until the end of the lockup period. We develop a model in which managers strategically underprice IPOs to maximize personal wealth from selling shares at lockup expiration. First-day underpricing generates information momentum by attracting attention to the stock and thereby shifting the demand curve for the stock outwards. This allows managers to sell shares at the lockup expiration at prices higher than they would otherwise obtain. We test the model on a sample of IPOs in the 1990s. We find that higher ownership by managers is positively correlated with first-day underpricing, underpricing is positively correlated with research coverage, and research coverage is positively correlated with stock returns and insider selling at the lockup expiration. These results are consistent with the model.

JEL classification: G14; G32

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1. Introduction

Why are initial public offerings (IPOs) underpriced? There are many reasonable explanations for moderate amounts of underpricing in the literature (see Jenkinson and Ljungqvist, 2001). The historical norm for first-day underpricing in developed countries has been about 15%. In recent years, however, a new phenomena has arisen – extreme underpricing. While there is no precise definition of extreme underpricing, situations of more than 50% first-day underpricing were common in the late 1990s, especially for internet firms. Issuing owner–managers seem unconcerned about situations of extreme underpricing, even though substantial proceeds are forgone. In a survey of chief financial officers (CFOs) that took their firms public, Krigman et al. (2001) find that CFOs of virtually all of the most underpriced firms are highly satisfied with the performance of their lead IPO underwriter.

We develop a model that highlights the potential benefits of substantial underpricing to owner–managers. Since owner–managers are typically discouraged from selling shares at the time of the IPO, their first opportunity to diversify their wealth is by selling at or after the lockup expiration. For example, only 26.4% of the firms in our sample have any secondary shares sold in the IPO and rarely does management sell these shares. Instead, owner–managers wait until the lockup period expires. The lockup is an agreement between the underwriter and the issuing firm prohibiting the sale of shares by insiders for a period of time after an IPO. The average lockup period lasts six months. When the lockup period ends, insiders (owner–managers) are able to sell shares previously restricted from sale. Owner–managers interested in maximizing their personal wealth will focus on the lockup-expiration share price rather than the IPO offer price. The cost of underpricing the IPO is a secondary consideration.

We argue that substantial underpricing generates information momentum, which shifts the demand curve for the firm's stock outwards. Our idea of information momentum is that by underpricing the issue, the large run-up in the stock price on the first day attracts interest from research analysts and the media. Analysts provide more recommendations and research reports for the hottest IPOs. This enhanced coverage brings the stock to the attention of more investors, shifting out the demand curve for the stock. The owner–manager then exploits this additional demand when he sells shares at the expiration of the lockup period. Thus underpricing, even substantial underpricing, can maximize the owner–manager's wealth. Note that the owner–manager's intentional underpricing results in an opportunity cost to the firm in terms of forgone proceeds from the IPO. These forgone proceeds lead to long-run underperformance (Ritter, 1991). In our model, the manager trades off the benefits of information momentum against the opportunity cost of the forgone proceeds for the firm.

We test the model using a sample of 618 IPOs from 1994 to 1999. Consistent with the model, firms in which managers retain more shares and hold more options have greater first-day underpricing. Firms with greater first-day underpricing receive significantly more recommendations from research analysts in the months leading up

to the lockup expiration than do firms with less first-day underpricing. This increased coverage from research analysts, especially non-lead underwriter analysts, leads to higher stock prices at the lockup expiration. Finally, insiders sell more shares in the open market and through secondary offerings when there is more non-lead analyst research coverage.

Our model of IPO underpricing differs from those in the literature in that it does not assume that any party has an informational advantage. For example, Chemmanur (1993) argues that owner–managers of high quality firms will underprice the IPO to induce investors to produce information about the firm. The more information that is produced, the more likely it is that a high quality firm is revealed to be high quality, allowing the firm to sell shares in a secondary offering at prices closer to the firm's true value. Spiess and Pettway (1997) empirically test Chemmanur's (1993) model. They find no evidence that firms recover the cost of an underpriced IPO in either higher seasoned offering proceeds or in greater wealth for the firms' owners through sales of shares in follow-on seasoned offerings.

Several other models address similar issues. Hakenes and Nevries (2000) present a model in which underpricing generates publicity for a firm, attracting customers, and thereby increasing fundamental firm value. In our model, underpricing decreases fundamental firm value. Boehmer and Fishe (2001) present a model in which underpricing generates trading volume, which benefits the lead underwriter because the lead underwriter is also the dominant market-maker for the stock. In their model, there is no direct benefit of underpricing to the issuing firm, which is the focus of our model. Ljungqvist et al. (2002) present a model in which underpriced shares are sold to institutional investors who then gradually sell them to sentiment investors in hot issue markets. Their model captures many of the features of our model, including underpricing and long-run underperformance, and generates some additional empirical implications.

Several recent empirical papers examine issues related to those in this paper. Studies by Field and Hanka (2001), Brav and Gompers (2000), Ofek and Richardson (2000), and Bradley et al. (2001) show that stock prices for new issues regularly decline at the time of the lockup expiration. These results suggest that there are downward sloping demand curves for new issues. Kaul et al. (2000) review the existing evidence and empirically document downward sloping demand curves for common stock. These results are consistent with our results.

Reese (2000) documents that IPOs with higher levels of underpricing have significantly higher trading volume for three years following the IPO. Rajan and Servaes (1997) examine the relationship between underpricing and analyst provision of earnings estimates on the Institutional Brokers Estimate System (IBES) for IPOs from 1975 to 1987. They document that the number of analysts providing earnings estimates on IBES is positively associated with firm size and IPO underpricing. Bradley et al. (2001) provide evidence that six-month returns through the end of the lockup period are positively related to the number of analysts initiating research coverage. These results are also consistent with our empirical results.

Schultz and Zaman (2001) examine internet IPOs in the 1990s and document moderate insider selling in the IPOs and in subsequent seasoned equity offerings.

They conclude that the speed with which internet firms went public is more consistent with internet firms needing to build market share quickly than with insiders seeking to liquidate ownership. They do not explicitly look at selling around lockup expirations, which is the focus of our paper. Finally, Loughran and Ritter (2002) argue, based on prospect theory, that due to the positive covariance between managerial wealth changes and underpricing, managers are not unhappy with highly underpriced deals. This explanation is complementary to ours.

The remainder of our paper proceeds as follows. Section 2 presents our model of strategic underpricing by owner–managers. Section 3 describes the data we use in our empirical work. Section 4 presents the hypotheses tested and the empirical results. Section 5 discusses alternative explanations for our findings and concludes.

2. A model of strategic underpricing

Consider an owner–manager taking his firm public. Selling a fixed quantity of shares (Q_0) to the public, the owner–manager must choose a price (P_0) at which to sell the shares. The firm retains the proceeds from the IPO, P_0Q_0. After the IPO, the total number of shares outstanding (including those shares held by the owner–manager) is N. After the Q_0 shares are allocated in the IPO, the shares publicly trade at a price P_1, which is the opening market price. We assume there is a lockup period in effect. At the end of the lockup period, the owner–manager can sell additional shares to the public out of personal shareholdings. The owner–manager chooses the quantity Q_2 to sell. The market sets a price P_2 to clear the market. Over time, the (fundamental) value of the firm is realized. We model the long run for the firm as a price $P_3 = f(P_0Q_0)$. We can think of this as the price, P_3, associated with the long-run value of the investment of the IPO proceeds. There are many other factors that also determine the long-run value of the firm from which we abstract. What is important in the model is that the manager places some value on the IPO proceeds in order to choose a non-zero IPO price.

Market-clearing prices are determined as follows. We assume that there is a downward sloping demand curve for stocks. We are assuming that investors are inherently heterogeneous in their valuations for stocks, in particular for new issues, consistent with Miller (1977). This assumption departs from the usual assumption that stocks are always priced at their fundamental value. The price set in the market when the stock trades at time one is:

$$P_1 = A - kQ_0. \tag{1}$$

A is the intercept and k the slope of the demand curve for the stock, where $k > 0$. The stock's price is set by the marginal investor's valuation.

A market-clearing price is also required at time two. At $t = 2$, investors can observe the evolution of prices from the IPO offer price P_0 to the open price of P_1 and can condition their demand for the stock on this information. In particular, we assume that investors are attracted to stocks that perform well at the open. We call this information momentum, and it is consistent with the existence of noise traders who

condition on limited public information (see Hong and Stein, 1999; Shiller, 1984). Information momentum shifts the market demand curve for the stock outwards. At $t=2$, the owner–manager sells more stock as the lockup period expires. This additional supply of stock Q_2 represents a movement down the demand curve. The price set in the market is given by the demand curve:

$$P_2 = A+\mathrm{g}(\Delta P) - k(Q_0 + Q_2). \tag{2}$$

A is the intercept and k is the slope of the demand curve for the stock. The demand curve at $t=2$ differs from the demand curve at $t=1$ by the additional equity sold Q_2 and the term $g(\Delta P)$, which represents the momentum effect. Momentum depends upon the price change from $t=0$ to 1: $\Delta P = P_1 - P_0$. We assume that the momentum generating function g is increasing, $g'>0$, and concave, $g''<0$, for $\Delta P \geqslant 0$. We also assume that if there is no momentum, there is no momentum effect, i.e., if $\Delta P = 0$ then $g(0)=0$ and $g'(0)=\infty$. Our assumptions allow for the possibility that momentum may be negative. However, in equilibrium, we will not observe negative momentum or overpricing ($\Delta P<0$). In practice, some IPOs are overpriced. Our model does not address this feature of the data, but an extension of our model to allow for uncertainty could easily reconcile instances of overpricing.

These assumptions about momentum imply that greater underpricing shifts the demand curve out, but at a decreasing rate. Intuitively, one can imagine that investors cannot and do not follow all stocks. They rely on outside information sources such as the media and research analysts to bring stocks to their attention. For firms conducting IPOs, underpricing, and especially extreme underpricing, is a way to attract attention from research analysts and the media. Coverage by these information sources then attracts investors and shifts out the demand curve for the stock.

The timing of the model is as follows. At $t=0$, given a quantity of shares to issue Q_0, the owner–manager chooses the IPO offer price P_0. At $t=1$, the market sets a trading (open) price of $P_1(Q_0)$. At $t=2$, the lockup period expires, the owner–manager chooses to sell Q_2 shares, and the market sets a price of: $P_2(Q_2, Q_0, \Delta P)$. At $t=3$, fundamental value $P_3=f(P_0Q_0)$ is realized. For simplicity, we assume that there is no discounting. We make the following additional assumptions:

Assumption 1. $N \geqslant (A+g(A))/k$. This assumption ensures that the owner–manager does not try to sell more shares than have been authorized. An alternative way of saying this is that there is no supply constraint; the number of shares authorized is sufficient to meet demand.

Assumption 2. There exists a $\underline{P}_0$ that maximizes long-run firm value per share $P_3 = f(P_0Q_0)$. In other words define:

$$\underline{P}_0 = \operatorname{argmax} f(P_0\mathrm{Q}_0) \tag{3}$$

where $f(P_0Q_0)$ is assumed to be a strictly concave function and $f'(0)=\infty$. Any capital provided to the firm beyond $\underline{P}_0Q_0$ would be wasted because the firm would have exhausted all positive NPV projects.

Assumption 3. $A \geqslant kQ_0 + f(\underline{P}_0 Q_0)$. This assumption ensures that there is sufficient demand for the stock. It also ensures that there is enough heterogeneity in investors' valuations so that the owner–manager finds it optimal to sell shares at the expiration of the lockup period. If there is not enough heterogeneity, then the owner–manager will not be able to exploit momentum by strategically underpricing.

We solve the model backwards. At $t = 3$, there is no choice to be made by the owner–manager. Fundamental value is realized and the owner–manager's remaining equity stake in the firm is worth:

$$(N - Q_2 - Q_0) f(P_0 Q_0). \tag{4}$$

$f(P_0 Q_0)$ is the stock price at time three and the owner–manager retains $N - Q_2 - Q_0$ shares.

At $t = 2$, the owner–manager chooses the number of shares to be sold at the expiration of the lockup Q_2 by maximizing the value of his holdings in the firm:

$$\max_{Q_2} (A + g(\Delta P) - k(Q_0 + Q_2))Q_2 + (N - Q_0 - Q_2) f(P_0 Q_0). \tag{5}$$

Recall that $A + g(\Delta P) - k(Q_0 + Q_2)$ is the market clearing price at $t = 2$ given that the owner–manager sells Q_2 shares at $t = 2$. Therefore, the first term captures the proceeds from the shares sold at $t = 2$ by the owner–manager. The second term captures the value of the owner–manager's remaining shareholdings at $t = 3$, taking into account that these shareholdings are reduced by the shares sold at $t = 2$. The optimal choice of Q_2 is:

$$Q_2^* = \frac{A + g(\Delta P) - kQ_0 - f(P_0 Q_0)}{2k}. \tag{6}$$

As long as $\Delta P \geqslant 0$, then the assumption that $g' > 0$ and Assumption 3 guarantee that $Q_2^* > 0$. To see this, note that for any $P_0, f(P_0 Q_0) \leqslant f(\underline{P}_0 Q_0)$, so the numerator must be positive. The key point about the number of shares sold at the expiration of the lockup period is that this quantity is increasing in the value of momentum $g(\Delta P)$. The market-clearing price P_2 is:

$$P_2^* = \frac{A + g(\Delta P) - kQ_0 + f(P_0 Q_0)}{2}. \tag{7}$$

This is also increasing in the value of momentum.

Continuing to solve the model backwards, at $t = 1$, the market-clearing price P_1 (i.e., the price at the open) is:

$$P_1^* = A - kQ_0. \tag{8}$$

At $t = 0$, the owner–manager chooses an IPO offer price of P_0 to maximize the value of his holdings in the firm:

$$\max_{P_0} P_2^* Q_2^* + (N - Q_0 - Q_2^*) f(P_0 Q_0). \tag{9}$$

The first term is the value of the shares sold at the expiration of the lockup period and the second term is the value of the owner–manager's long-term holdings. Because the owner–manager receives none of the IPO proceeds (by assumption),

these do not enter his wealth function. The following proposition establishes the optimal choice of P_0 and shows that in equilibrium there will be underpricing.

Proposition. *In equilibrium*, $P_0^* < A - kQ_0$ $(= P_1^*)$ *and* $P_0^* < \underline{P}_0$.

Proof. The first order condition from Eq. (9) is:

$$\left(-g'(\Delta P) - Q_0 f'(P_0 Q_0)\right)\frac{A + g(\Delta P) - kQ_0 - f(P_0 Q_0)}{2k} + Q_0 f'(P_0 Q_0)(N - Q_0). \tag{10}$$

We first note that the IPO offer price will be positive. At $P_0 = 0$, the first order condition reduces to:

$$Q_0 f'(0)(N - Q_0 - Q_2) - g'(\Delta P)Q_2 > 0, \tag{11}$$

because $f'(0) = \infty$, and Assumption 1 implies that $N - Q_0 - Q_2 > 0$ for all possible Q_0 and Q_2. Therefore, $P_0^* > 0$. Next we note that $P_0 \leqslant A - kQ_0$ because, if not, $P_0 > A - kQ_0$ implies that the market for the Q_0 shares does not clear at time 1. Now consider two cases. First, suppose that $A - kQ_0 \leqslant \underline{P}_0$. At $P_0 = A - kQ_0$, the first order condition reduces to:

$$(-g'(0) - Q_0 f'(P_0 Q_0))\frac{A - kQ_0 - f(P_0 Q_0)}{2k} + Q_0 f'(P_0 Q_0)(N - Q_0) < 0, \tag{12}$$

because $g'(0) = \infty$ and $A - kQ_0 - f(P_0 Q_0) > 0$ by Assumption 3. Hence, $P_0^* < A - kQ_0$. Second, suppose that $A - kQ_0 > \underline{P}_0$. At $P_0 = \underline{P}_0$, note that $f'(\underline{P}_0 Q_0) = 0$ by Assumption 2. The first order condition reduces to:

$$-g'(\Delta P)\frac{A + g(\Delta P) - kQ_0 - f(\underline{P}_0 Q_0)}{2k} < 0. \tag{13}$$

Further, $f'(P_0 Q_0) < 0$ for $A - kQ_0 \geqslant P_0 > \underline{P}_0$, implying that the first order condition is negative for P_0 in this interval. Hence, $P_0^* < \underline{P}_0$. Consequently, $P_0^* < A - kQ_0$ and $P_0^* < \underline{P}_0$ in both cases. □

The key implication of the proposition is that the owner–manager never chooses the IPO offer price that maximizes proceeds ($P_0 = A - kQ_0$). The owner–manager also never chooses the long-run firm value-maximizing IPO offer price $\underline{P}_0$. The owner–manager instead takes advantage of the momentum effect and strategically chooses a lower IPO price. This allows the owner–manager to sell more shares at a higher price when the lockup period expires. As a result, our model generates IPO underpricing where the owner–manager does not choose an offer price that is the equilibrium price at the start of trade (P_1). Due to the momentum effect, a small amount of underpricing generates large marginal benefits for the owner–manager by shifting the demand curve at $t = 2$. Fig. 1 depicts price and quantity choices over time for the model.

Given this setup, we can now derive some additional implications, which are demonstrated graphically in Fig. 1. First, momentum will be positive, $g(\Delta P) > 0$. This follows because $P_1^* = A - kQ_0 > P_0^*$. In other words, by choosing an IPO price less

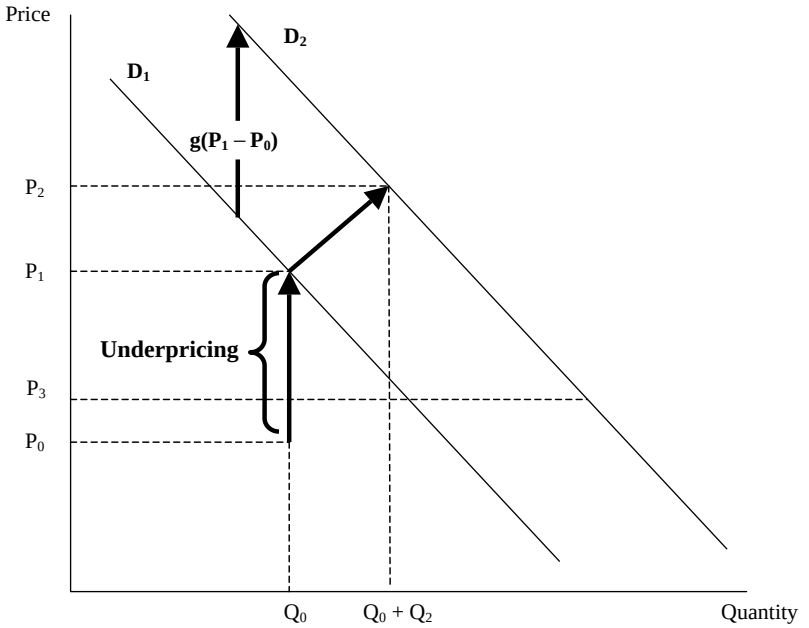

Fig. 1. Price as a function of quantity of shares sold. At $t = 1$, an IPO offer price P_0 is chosen by the owner–manager. The open (trading) price is $P_1 = A - kQ_0$, and is determined by the intersection of the offered quantity Q_0 and the demand curve D_1 for the stock. As a result of underpricing, momentum $g(P_1 - P_0)$ shifts the demand curve at $t = 2$ up to D_2. At the expiration of the lockup period, the owner–manager sells an additional Q_2 shares. The price at $t = 2$ is given by the demand curve $P_2 = A + g(P_1 - P_0) - k(Q_0 + Q_2)$. In the long run, the fundamental price P_3 for the stock is realized.

than the price at the start of trade, the owner–manager is able to induce positive momentum.

Second, P_2 will be greater than otherwise were there no momentum effect, which creates the reason to underprice in the first place. In Fig. 1, $Q_0 + Q_2$ intersects D_1 below where it intersects D_2. Because momentum shifts the demand curve out to D_2, shares sold at time two are traded at a higher price than would be attainable if the demand curve remained at D_1. If the momentum effect is large enough, it is possible that P_2 will be greater than P_1, as shown in Fig. 1. However, it is also possible that, if the owner–manager sells enough shares at the lockup expiration, P_2 is less than P_1. This is the consequence of the owner–manager moving down the demand curve for the stock by selling more shares.

Third, given that momentum is positive, P_2 will be greater than P_3. This is intuitive, as the owner–manager would not choose to sell any shares at $t = 2$ if the price were less than the price at $t = 3$. In this sense, we view the investors who buy shares at the expiration of the lockup period as noise traders. The owner–manager is selling these investors shares that are overvalued. A further implication of this point is that, in the long-run, IPOs will underperform. This occurs for three reasons. First, momentum can be thought of as a short-run distortion in the demand curve that

reverses when prices return to fundamental values of P_3. Second, as insiders sell more shares over time, the price per share will decrease as a result of moving down the demand curve. Third and more subtly, by underpricing the IPO, the owner–manager forgoes IPO proceeds, which reduces long-run firm value per share P_3.

The model generates the following empirical implications. Recall from Eqs. (6) and (7) that the number of shares sold at lockup expiration and the stock price at lockup expiration are increasing in the value of momentum, $g(\Delta P)$. Furthermore, we assume that underpricing generates momentum. These statements are what we test.

One might also wonder about the implications of the model for how the number of shares issued in the IPO, Q_0, affects underpricing. This turns out to be ambiguous. To see this, suppose that fewer shares are issued at the IPO. First, suppose the marginal value of increasing momentum is greater than the marginal value of increasing the long-run value of the firm through increasing IPO proceeds. In this case, the owner–manager will underprice more to take advantage of the momentum. Conversely, suppose that the marginal value of increasing the long-run value of the firm through increasing IPO proceeds is greater than the marginal value of increasing momentum. In this case, the owner–manager will underprice less to take advantage of the long-run firm value. As a result, the relationship between the number of shares issued at the IPO and underpricing depends on the relative strength of momentum versus long-run firm value. Nonetheless, if information momentum is an important and strong force as we posit, then we should see more underpricing associated with fewer shares being issued (or more shares being retained) by the owner–manager in the IPO.

There are several additional points to note about the model. First, one may wonder about the assumption that the number of shares sold at the IPO Q_0 is taken as fixed. This assumption is consistent with how IPOs actually occur. When the owner–manager decides to take the company public, the owner–manager employs an investment banker who indicates how many shares are to be offered. During the book building process, the investment banker and the owner–manager learn about the demand curve for the firm's stock. As a result of this process, an IPO price is chosen. Thus, at the time of IPO pricing, the quantity of shares to be sold has already been set. While there can be some quantity adjustment up until the time of the IPO, this is usually much less than the price adjustment that occurs prior to the IPO. Logue et al. (2002) document that the median firm does not alter the number of shares offered in the IPO.

While we view this modeling choice as the most realistic, we can also endogenize the choice of Q_0 in our framework. This requires that the demand curve for the stock be known prior to the choice of the number of shares to issue. None of our empirical implications are affected if we do this, nor are additional empirical implications generated. In general, we cannot rule out the possibility of a corner solution in which the owner–manager chooses to issue a minimum number of shares at an arbitrarily close-to-zero price in order to maximize information momentum. In this case, the number of shares to issue would be set exogenously by either imposing a constraint that requires a minimum level of IPO proceeds or imposing a constraint that requires a minimum number of shares to be issued to ensure liquidity for the stock. As

Table 1 shows, the median company in our sample issues four million shares in the IPO, and two-thirds of our companies issue between two and four million shares. Taking Q_0 as fixed is a reduced-form way of imposing a constraint on the minimum number of shares offered. Habib and Ljungqvist (2001) test for whether underpricing influences the number of shares sold in the IPO and find that the number of shares sold is exogenous to underpricing. This result is consistent with our model.

Second, we have modeled the cost of strategic underpricing as the reduction in long-run firm value that results from forgoing some IPO proceeds. In general, another cost of IPO underpricing for the owner–manager is the dilution of his equity ownership as a result of issuing more shares in the IPO for a given level of IPO proceeds. In our model, one consequence of taking the number of shares issued in the IPO Q_0 as fixed is that we do not consider the costs of dilution. In order to consider dilution, we would have to fix the level of IPO proceeds and allow the number of shares issued to vary. Instead, we fix the number of shares to be issued and allow the level of IPO proceeds to vary and be chosen optimally by the owner–manager. We cannot say in general (either theoretically or empirically) whether the information momentum benefits outweigh the dilution costs of underpricing.

Third, it may seem that investors should be able to figure out that there will be an increase in shares trading at the expiration of the lockup and wait to buy then. There are several possible explanations for why investors do not wait, but the model is not designed to explain this behavior. Instead, the model asks whether owner–managers can exploit this behavior by investors. As for explanations for why investors do not wait, investors may have heterogeneous valuations for liquidity or portfolio reasons. In this case, some investors need to hold the security independent of whether price drops can be anticipated. As another explanation, it is possible that investors who are allocated shares in the IPO continue to hold them in order to get future allocations of IPOs. While they can lose money by not selling prior to time two, they still gain because it is possible for P_0 to be less than P_3. A third possibility is simply that boundedly rational investors or noise traders do not foresee the additional supply created by the expiration of the lockup period.

Fourth, our model does not explicitly incorporate a role for the underwriter, except through the underwriter analyst's contribution to information momentum. Clearly, the underwriter is an important player in the going-public process. The underwriter can have different incentives than the owner–manager for underpricing new issues. Underwriters may wish to underprice to minimize their risk of holding unallocated shares or to compensate investor clients for other business done through the investment bank. Here we focus on the relationship between the owner–manager and the market and abstract from the relationship between the firm and the underwriter. In particular, our model highlights the owner–manager's incentives to allow or encourage underpricing to occur. Nonetheless, we are careful to control for underwriter characteristics in our ensuing empirical work.

It may be helpful to think about specific situations in which we think our model will apply. The key condition for our model is that the value of information momentum must be sufficiently high so as to significantly shift out the demand curve for a new issue by the expiration of the lockup period. Intuitively, such a condition is

Table 1
Sample statistics, internet and non-internet related IPOs

The sample consists of 618 firms that completed an initial public offering (IPO) between January 1994 and December 1999. We include all internet-related IPOs and a matched sample of non-internet IPOs based on offering size and IPO date. Data presented include the mean and median offer price per share, the number of shares offered in the IPO, the number of shares outstanding following the IPO, the proceeds raised in the IPO, the market value of equity post IPO, the percentage change in price from the mid-point of the initial filing range to the offer price, the offer to open return at the IPO, the day one open to close price-only return, the percentage of the sample that was backed by venture capital prior to the IPO, the percentage of shares sold at the IPO that were secondary shares, the day one total trading volume as a percentage of the number of shares offered, the number of days in the lockup provision, and the six-month return following the IPO (measured using the first closing market price). *p*-values for a parametric and nonparametric test of the null hypothesis that the internet sample is equal to the non-internet sample are provided.

	Full sample		Internet IPOs		Non-internet IPOs		*t*-test	Kruskal–Wallis
	Mean	Median	Mean	Median	Mean	Median	*p*-value	*p*-value
Observations	618		303		315			
Offer price	14.00	14.00	13.92	14.00	14.06	14.00	[0.7446]	[0.3891]
Shares offered (000)	4,756	4,000	4,917	4,000	4,601	4,000	[0.2478]	[0.0942]
Shares outstanding (000)	26,938	15,258	31,689	16,883	22,354	13,008	[0.0575]	[0.0009]
Shares offered as % shares outstanding	25.9%	22.0%	23.4%	20.2%	28.5%	25.0%	[0.0001]	[0.0002]
Proceeds ($ million)	73.12	53.45	74.82	54.00	71.48	52.50	[0.5675]	[0.4823]
Market value of equity ($ million)	778.08	270.48	948.14	338.22	613.97	234.79	[0.0019]	[0.0006]
Change in price from initial filing	13.6%	9.6%	18.3%	14.3%	9.1%	7.7%	[0.0001]	[0.0001]
Offer price to opening return	50.4%	23.3%	66.2%	33.3%	35.2%	17.6%	[0.0001]	[0.0001]
First-day open to close return	3.4%	0.7%	2.7%	0.0%	4.0%	1.3%	[0.3775]	[0.0216]
% venture backed	51.1%		58.7%		43.8%			
% secondary shares offered	6.8%	0.0%	3.3%	0.0%	10.2%	0.0%	[0.0001]	[0.0001]
Day 1 volume as % shares offered	129.2%	114.2%	159.7%	147.6%	99.9%	88.3%	[0.0001]	[0.0001]
Days in lockup provision	188.0	180.0	182.2	180.0	193.6	180.0	[0.1234]	[0.3283]
Six-month return	31.78%	−1.12%	49.65%	−4.23%	14.59%	0.00%	[0.0006]	[0.7917]

likely to be met in hot IPO markets. When many firms in the same industry are going public, significant underpricing enables a firm to catch the attention of the media and research analysts, who can follow only a limited number of stocks. The most recent example is the hot IPO market of the late 1990s, dominated by internet companies. During this time period, there were many cases of managers taking firms public very quickly, often within a couple of years of founding the company. These managers became quite wealthy on paper. Our model suggests the strategic behavior that managers might take to facilitate transforming paper wealth into real wealth as quickly as possible.

3. Data and sample selection

This section describes the sample and the data that we use to test our model of strategic underpricing. We examine IPOs in 1994 through 1999, a period during which there were many IPOs with extreme (more than 50%) first-day underpricing. Many of the IPOs with extreme underpricing are in internet-related businesses. When we test our model, we do not want our sample to be dominated by internet IPOs. We are careful therefore to construct a sample of both internet-related and non-internet-related IPOs. We first choose firms that conducted an IPO between January 1993 and December 1999 and that were identified as internet-related from the Securities Data Company (SDC) *New Issues Database*. This yields 316 internet-related IPOs during the years 1993 through 1999. We then augment the sample by adding 316 representative non-internet-related companies. In order to make these companies as comparable as possible, we choose non-internet-related IPOs that are closest in offering size (IPO proceeds with a maximum differential of 10%) and IPO date (in calendar time) to our internet-related IPOs. Our final sample contains 618 firms.[1] In our final sample, 171 firms had underpricing in excess of 50% on the first day of trading, and two-thirds of these were internet-related.

The data come from several sources. We use SDC's *New Issues Database* for data on the characteristics of the IPO: the offering date, offer price, lead underwriter, and the number of primary and secondary shares offered in the IPO. Additional data on the shares and options held by managers and insiders at the time of the IPO are from the offering prospectuses (labeled S1 to S4) filed with the SEC using the on-line Edgar database or other equivalent sources. We use trade and quote data from the New York Stock Exchange's TAQ Database to measure a firm's underpricing, defined as the return from the offer price to the opening trade price.

The theory posits that underpricing generates information momentum. We use research analyst reports as a proxy for information momentum generation. We use the Thomson Financial Services First Call Database (First Call 4.2) to identify

[1] Missing data required the removal of 13 internet IPOs and one non-internet IPO. All three IPOs from 1993 were eliminated due to missing data. As a result, our final sample runs from 1994 to 1999. We do not perform any paired tests across the internet and non-internet firms. Thus, the unbalanced sample (303 internet firms and 315 non-internet firms) is not an issue.

the timing and quantity of research recommendations and comments made on each IPO. We track the number of brokers making comments and the total number of times a firm is mentioned on First Call, and we partition the number of recommendations made specifically about each company by the IPO lead underwriter's analyst and by other non-lead underwriter analysts. We collect these data from the time of the IPO through one month following the expiration of the lockup provision.

The model predicts that information momentum increases returns between the IPO and the expiration of the lockup period. We use data from the Center for Research in Security Prices (CRSP) to examine returns between the IPO and the lockup expiration. The model also predicts that information momentum increases insider selling at the expiration of the lockup period. We use insider-trading data from the Dialog Insider Trading Monitor. This database has the transactions details of all insider filings received by the U.S. Securities and Exchange Commission (SEC) beginning in January 1984. The data contain all securities transactions by officers, directors, management and major shareholders. We include the following positions in our definition of insiders: Chairman of the Board, President, Chief Executive Officer, Chief Financial Officer, Chief Operating Officer, Vice President, General Partner, Officer, Director, Chief Accounting Officer, and Controlling Person. The transactions are dated and coded by the type of transaction. They also contain the name and position of the insider, the number of shares, and the transaction price.

Finally, we include several control variables in various parts of our empirical analysis. We include short interest outstanding for the five months surrounding the expiration of the lockup provision for each firm. For firms listed on Nasdaq, data on short interest are from Nasdaq. For firms listed on the NYSE, data on short interest are from Bloomberg. We also include a measure of the quality of the IPO based on the ranking of the lead underwriter. We assume that higher quality offerings are underwritten by higher quality investment banks, and that higher quality investment banks have greater market share in terms of IPO proceeds raised (see Megginson and Weiss, 1991).[2] The data on market share by investment bank are from SDC and are constructed using all IPOs, not just those in our sample.

Tables 1 and 2 contain summary statistics on the primary data sample. In our sample, 290 IPOs, or 47% of the sample, are from calendar year 1999. We control for changes in the IPO market through time in the ensuing empirical analyses. In Table 1, the average firm offers 25.9% of its shares in the IPO as a percent of the

[2] Lead underwriter rank is constructed as follows. For a set of underwriters I and for every year t, we define the three-year moving average ($t-2$, $t-1$, t) of IPO proceeds lead underwritten by underwriter j as x_{jt}. Then the lead underwriter rank (LUR) for underwriter j is:

$$LUR_{jt} = \frac{\ln x_{jt}}{\max_{i \in I}[\ln x_{it}]}.$$

Under this measure, the underwriter with the highest three-year moving average of IPO proceeds for time t will have a lead underwriter rank of 1. This measure of underwriter quality is market-share based and is a continuous variable on [0,1].

Table 2
Management shareholding data and First Call research coverage

The sample consists of 618 firms that completed an IPO between January 1994 and December 1999. We include all internet-related IPOs and a matched sample of non-internet IPOs based on offering size and IPO date. Panel A contains the number of common shares outstanding, the number of shares held by management following the IPO, and the percentage of shares outstanding held by management. We also provide the number of options to purchase shares held by management following the IPO, the weighted-average exercise price of the options, and the number of options as a percentage of the shares offered in the IPO and as a percentage of the total shares outstanding. Panel B contains details of research coverage, as provided by First Call, from the time of the IPO through one month following the expiration of the lockup provision. Data are provided for firms with First Call coverage. The total First Call mentions is the number of comments that mention the firm during the period including industry comments. The number of brokers is specific to brokers making recommendations (buy, hold, sell) on the firm. The data are partitioned by lead underwriter and non-lead underwriter analyst recommendations. Panel C contains the number of shares sold by insiders from two months prior through two months following the expiration of the lockup provision. It also reports the shares sold as a percentage of total shares outstanding. *p*-values for a parametric and nonparametric test of the null hypothesis that the internet sample is equal to the non-internet sample are provided.

	Full Sample		Internet IPOs		Non-Internet IPOs		*t*-test	Kruskal–Wallis
	Mean	Median	Mean	Median	Mean	Median	*p*-value	*p*-value
Panel A: Management shareholdings data								
Observations	618		303		315			
Shares outstanding (000)	26,938	15,258	31,689	16,883	22,354	13,008	[0.0575]	[0.0009]
Shares held by management (000)	10,610	6,741	12,073	8,037	9,927	5,999	[0.0095]	[0.0001]
Percent shares held by management	43.2%	47.1%	43.6%	47.7%	42.8%	45.7%	[0.6706]	[0.7487]
Options held by management (000)	2,594	1,464	3,257	1,901	2,089	1,214	[0.0001]	[0.0001]
Weighted average exercise Price	$4.68	$3.20	$4.02	$2.95	$5.40	$3.75	[0.0034]	[0.0043]
Options as % of shares offered	55.5%	41.1%	64.6%	47.9%	46.7%	30.0%	[0.0013]	[0.0001]
Options as % of shares outstanding	13.4%	9.9%	15.3%	11.4%	11.7%	7.9%	[0.0027]	[0.0001]
Panel B: First Call research coverage								
Firms with no First Call coverage	99	(16.0%)	48	(15.8%)	51	(16.2%)		
Firms with First Call coverage	519	(84.0%)	255	(84.2%)	264	(83.8%)		
Total First Call mentions	83.81	60.00	104.46	79.00	63.87	40.50	[0.0001]	[0.0001]
Number of brokers	3.98	4.00	4.49	4.00	3.49	3.00	[0.0001]	[0.0001]
Recs. by lead analyst	5.44	5.00	5.85	5.00	5.05	5.00	[0.0022]	[0.0402]
Recs. by non-lead analysts	12.38	10.00	14.29	12.00	10.55	9.00	[0.0001]	[0.0004]
Panel C: Insider selling around lockup expiration								
Firms with no inside selling at lockup exp.	366	(59.2%)	174	(57.4%)	192	(61.0%)		
Firms with selling at lockup exp.	252	(40.8%)	129	(42.6%)	123	(39.0%)		
Total Insider Sales	1,292,310	410,342	1,394,287	683,750	1,185,358	223,751	[0.3893]	[0.2121]
Percent of Shares Outstanding Sold	5.89%	1.91%	6.40%	2.03%	5.35%	1.34%	[0.3823]	[0.2423]

shares outstanding. Internet firms offer fewer shares in the IPO as a fraction of the shares outstanding than do non-internet firms.[3] The average proceeds from the offering are $73.1 million, with a mean offering price of $14 per share. The level of underpricing (measured as the offer to open return) is substantially higher than that found in previous studies, which is not surprising given our sample period and our focus on extreme underpricing. For the full data set, mean underpricing is 50.4%, with a median of 23.3%. The internet subsample has significantly greater underpricing (mean of 66.2% and median of 33.3%) than the non-internet subsample (mean of 35.2% and median of 17.6%). In addition, internet firms sold fewer secondary shares at the IPO than non-internet firms. Only 56 of 303 internet firms (18%) sold secondary shares at the IPO, compared to 107 of 315 non-internet firms (34%).

The median firm in both subsamples has a lockup period of 180 days. In fact, 507 of the 618 firms have lockup periods exactly equal to 180 days. Mean six-month returns, measured starting at the closing market price on the first day of trading, are significantly higher for internet firms than for non-internet firms. However, median six-month returns for non-internet IPOs are not significantly greater than median returns for internet IPOs.

Panel A of Table 2 provides details on the share and option holdings by management following the IPO. On average, managers hold 43.2% of the outstanding stock after an IPO while venture capitalists, angel investors, non-management employees, public shareholders, and others hold the rest. We find little difference in managerial shareholdings as a percentage of shares outstanding between the internet and non-internet IPOs. However, managers in internet firms hold significantly more options than managers in non-internet firms (3.26 million versus 2.09 million options on shares). For all firms, the share-weighted-average exercise price of the outstanding options is $4.68, significantly below the average IPO offer price of $14.00 per share.

We empirically define information momentum as greater research activity, which in the model causes a shift in the demand curve for a stock. Panel B of Table 2 contains summary statistics on First Call research coverage. In our sample, 16% of the firms have no research coverage on First Call from the time of the IPO until one month after the expiration of the lockup period. As noted in Rajan and Servaes (1997) in the context of IBES data, this is most likely due to First Call missing research coverage, rather than no research coverage occurring. For the firms in our sample that are mentioned on First Call, they are mentioned on average 83.8 times from the IPO date through one month following the expiration of the lockup provision. For the firms with research coverage, the mean number of brokers making recommendations is 3.98. For firms with research coverage, the lead underwriter's

[3] In Table 1, "shares offered as a percentage of post-issue shares outstanding" are reported as means and medians of the distribution of percentages. These percentages will not equal the mean (median) shares offered divided by the mean (median) shares outstanding because the distribution of percentages is not symmetric. The same is true in Table 2 for "percent shares held by management," "options as a percentage of shares offered," and "options as a percentage of shares outstanding."

analyst issues an average of 5.44 recommendations for the stock during the period compared to 12.38 recommendations for the set of non-lead analysts. Panel B also shows that internet stocks have significantly more research coverage in the period from the IPO through the lockup expiration.

Panel C of Table 2 provides summary data on insider selling around the expiration of the lockup period. In our full sample, 40.8% of the firms have insiders selling shares around the lockup expiration. The amount of insider selling is quite skewed, with mean selling much greater than median selling for those firms with any level of selling. We do not find significant differences between the internet and non-internet firms. As can be seen in Fig. 2, the amount of selling by insiders after the IPO is substantial. Interestingly, one hundred of 618 firms, or 16% of the firms, have insiders selling shares in advance of the lockup expiration. This finding is consistent with Brav and Gompers (2000), who report that 429 of 2,794 (15.4%) firms in their sample have insiders selling shares in advance of the lockup expiration. Insider selling prior to the expiration of the lockup is permitted with the express written consent of the lead underwriter. Early release from the lockup is more likely to occur after a large price run-up or during a quick follow-on offering. Not surprisingly, insider selling reaches a peak after the expiration of the lockup period, typically at the end of month six.[4]

4. Model implications and empirical results

We test the model in Section 2 by examining the following four empirical implications:

I. Managers who retain more shares after the IPO will underprice more.
II. Greater first-day underpricing of an IPO generates information momentum (in the form of higher levels of research coverage).
III. Increased research coverage leads to a higher stock price at the expiration of the lockup.
IV. The number of shares sold by management around the expiration of the lockup is increasing in research coverage.

The first implication is that managers with a greater ownership stake in the firm will want to underprice more. This implication is consistent with the models of Grinblatt and Hwang (1989) and Habib and Ljungqvist (2001). It will be true if the marginal value of information momentum is high. However, two alternative effects could dominate the desire for underpricing. First, managers underprice less if the marginal value of IPO proceeds to long-run firm value is high. Second, if managers

[4] Our data may understate the level of insider selling. Schultz and Zaman (2001) suggest that some managers use exchange funds provided by investment banks to synthetically sell part of their stake in an IPO firm. Executives from different firms contribute company stock into a fund and receive a pro rata share of the diversified portfolio. Technically, the use of an exchange fund is not considered a sale. Instead, it is a tax-deferred exchange that is not reported to the SEC until the portfolio is liquidated.

sell a greater portion of their own personal stake in the firm at the time of the IPO in the form of secondary shares, maximization of proceeds at the IPO can dominate the incentive for underpricing.

We estimate the following specification using ordinary least squares (OLS) to investigate the relationship between IPO underpricing and managerial shareholdings in the firm:

$$UP = \alpha + \beta_1 \log(Proceeds) + \beta_2 LUR + \beta_3\, Internet + \beta_4 \mathrm{VC} + \beta_5\, Co\text{-}Mgrs + \beta_6\, SecondaryShrs + \beta_7\, MgrShrs + \beta_8\, MgrOpts + \mu_t + \varepsilon. \quad (14)$$

The dependent variable, underpricing (*UP*), is the offer to open return on the IPO's first day. We control for the size of the offering by including log(*Proceeds*) and the

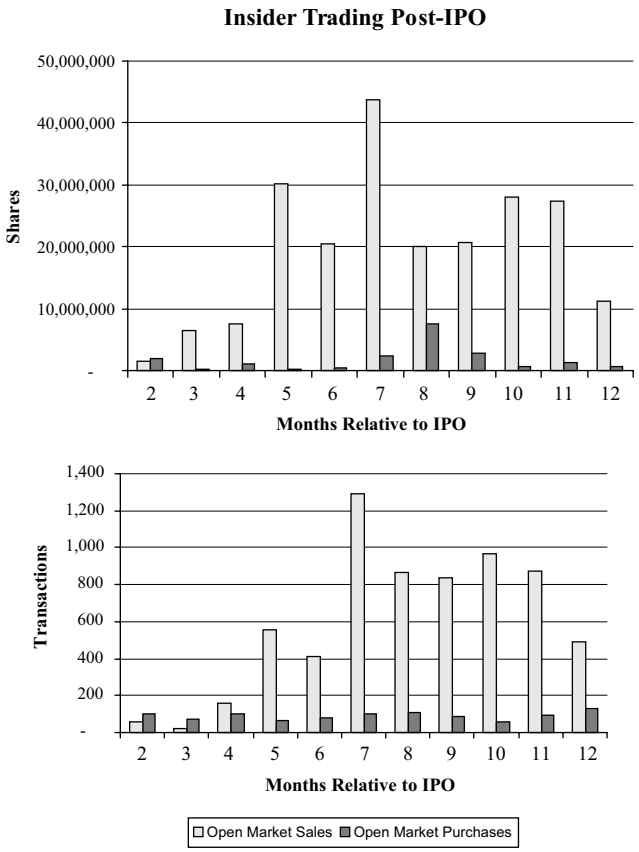

Fig. 2. Open market sales and purchases by insiders following IPO. The sample consists of 618 firms that completed an initial public offering (IPO) between January 1994 and December 1999. The top graph contains aggregate open-market shares sold and purchased by insiders as reported on the Dialogue Insider Trading Monitor across the 618 firms in our sample. The bottom graph contains the number of open-market sale and purchase transactions reported. Data are from months two through 12 following the IPO.

quality of the offering by including the rank of the IPO lead underwriter (*LUR*). We also include internet and venture capital (*VC*) indicator variables to control for differences between internet and non-internet firms and firms that are venture capital backed versus those that are not venture capital backed. We also control for the number of co-Managers at the IPO (*Co-Mgrs*). We include calendar year indicators μ_t to control for any time effects, including the effects of hotter and colder IPO markets. The independent variables of interest are the percentage of outstanding stock held by management (*MgrShrs*), the number of options held by management as a percentage of outstanding stock (*MgrOpts*), and the percentage of the shares sold at the IPO that were secondary shares (*SecondaryShrs*). The results are contained in Table 3.

There are several notable findings. Firms underwritten by higher quality investment banks underprice more (consistent with the results in Beatty and Welch, 1996), as do internet firms. Interestingly, the coefficient on the percentage of secondary shares sold in the offering is insignificant. It should be noted that, in our sample, only 26.4% of the firms have any secondary shares sold in the IPO. The first two columns report results separately for shares and options held by management.[5] Shareholdings are marginally significant for explaining the level of underpricing while option holdings are strongly significant. The third column shows that the options and share positions held by management are jointly significantly related to the level of underpricing with a p-value of 0.0017. Our model has no predictions for the importance of option holdings relative to shareholdings. Overall, the results are consistent with the implication that managers with larger holdings are more willing to underprice the IPO. However, these effects are not economically large. From the first column, an increase in managerial shareholdings of 10% is associated with increased underpricing of only 2.2%.

The second implication of the model that we test is that underpricing generates information momentum in the form of increased research coverage. As an initial investigation of this implication, we partition the sample by the level of underpricing at the IPO. We use the IPO underpricing cutoff levels from Krigman et al. (1999) to create four groups. Cold IPOs (51) are defined as having underpricing of zero or below. Cool IPOs (116) have underpricing of 0–10%. Hot IPOs (301) have underpricing ranging from 10% to 60% and extra-hot IPOs (150) are defined as having underpricing greater than 60%. In Table 4, the number of brokers following the stock, the number of recommendations made by the lead underwriter's analyst, and the number of recommendations made by non-lead analysts are all increasing in the level of underpricing. There is a small nonmonotonicity in the total number of mentions on First Call from cold to cool IPOs. Extra-hot IPOs were mentioned on First Call an average of 132.9

[5] In general, it would be more appropriate to delta adjust the option holdings (i.e., multiply the option holdings by the options' deltas) or use a further risk adjustment as in Hall and Murphy (2000). However, for our sample, these options' deltas are close to one. This is because the options are far in-the-money at the opening price (for the full sample, the mean opening price is $21 and the mean exercise price for the options is $4.68).

Table 3
OLS regressions of IPO underpricing
The sample consists of 618 firms that completed an IPO between January 1994 and December 1999. The dependent variable in the regressions is the offer to open percentage return on the day of the IPO. Independent variables include the log of the IPO proceeds in millions of dollars, the rank of the lead underwriter, an indicator for internet-related companies, an indicator for venture capital backed IPOs, and the number of co-Managers at the IPO. Calendar year indicator variables (the base year is 1996) are included but not reported. The variables of interest are shares and options held by management as a percentage of the number of shares outstanding, and the percentage of shares sold in the IPO that were secondary shares. The table contains the parameter estimates from OLS regressions with *p*-values in brackets.

	Model 1	Model 2	Model 3
Calendar year dummies	Yes	Yes	Yes
Intercept	−32.29 [0.0584]	−24.48 [0.1124]	−36.39 [0.0323]
Log of IPO proceeds	−3.27 [0.5231]	−2.30 [0.6507]	−1.08 [0.8333]
Lead underwriter rank	9.79 [0.0001]	8.85 [0.0001]	8.64 [0.0001]
Internet indicator	18.43 [0.0030]	17.55 [0.0044]	18.01 [0.0035]
Venture capital backed IPO indicator	0.61 [0.9227]	−0.47 [0.9400]	−1.63 [0.7946]
Number of co-Managers at IPO	−6.786 [0.0192]	−7.281 [0.0116]	−7.153 [0.0130]
Secondary shares at IPO	−0.10 [0.5827]	−0.10 [0.5931]	−0.08 [0.6690]
Percent management shares held	0.22 [0.0716]		0.20 [0.0965]
Percent management options held		0.17 [0.0015]	0.16 [0.0020]
p-value for joint significance of management shares and options held			[0.0017]
Adj. R^2	16.28%	17.22%	17.46%

times during the period from the IPO through one month following the expiration of the lockup provision. Non-lead analysts made recommendations on the extra-hot IPOs an average of 17.5 times during this horizon. In contrast, IPOs in the other three categories had substantially fewer recommendations by non-lead analysts. These univariate statistics are consistent with managers underpricing IPOs to generate increased research coverage and create information momentum.

Table 4
Research coverage and insider sales partitioned by IPO underpricing
The sample consists of 618 firms that completed an IPO between January 1994 and December 1999. We partition the data into four groups based on IPO underpricing. Cold IPOs are those with an offer to open return of zero percent or less, and extra-hot IPOs are those with an offer to open return greater than 60%. The partition of cool versus hot is split at 10%. Research coverage as gathered from First Call for the period from the IPO through one month following the lockup expiration is provided. The table includes the total number of mentions on First Call, the number of brokers making specific recommendations, and the number of recommendations made by the IPO Lead underwriter analyst and the aggregate number of recommendations made by non-lead analysts for only those firms with any First Call coverage. The table includes the number of shares and the percent of shares outstanding sold by insiders in the open market and through underwritten block transactions for firms that report insider sales during the four months surrounding the expiration of the lockup. The table also provides the mean and median six-month buy-and-hold return measured from the close of trading on the first day.

	Cold $UP \leqslant 0\%$		Cool $0\% < UP \leqslant 10\%$		Hot $10\% < UP \leqslant 60\%$		Extra Hot $UP > 60\%$	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Observations	51		116		301		150	
Six-month return from IPO	29.5%	3.7%	20.1%	−1.4%	31.4%	5.8%	42.4%	−19.0%
Six-month Nasdaq-adjusted return from IPO	−11.7%	−48.7%	2.6%	−13.0%	14.3%	−4.9%	17.8%	−27.9%
Firms with no First Call coverage	11	(21.6%)	22	(19.0%)	58	(19.3%)	8	(5.3%)
Firms with First Call coverage	40	(78.4%)	94	(81.0%)	243	(80.7%)	142	(94.7%)
Total First Call mentions	56.8	39.0	50.7	35.0	72.4	55.0	132.9	107.0
Number of brokers	2.9	2.5	3.1	3.0	3.7	3.0	5.2	5.0
Recommendations by lead underwriter analyst	4.6	4.5	5.1	5.0	5.3	5.0	6.2	5.5
Recommendations by non-lead analysts	8.0	5.0	8.1	7.0	11.8	10.0	17.5	16.0
Firms with no insider sales around lockup exp.	40	(78.4%)	85	(73.3%)	179	(59.5%)	62	(41.3%)
Firms with insider sales around lockup exp.	11	(21.6%)	31	(26.7%)	122	(40.5%)	88	(58.7%)
Shares sold by insiders	566,381	47,385	937,157	170,000	1,123,042	253,821	1,742,828	1,146,937
Shares sold as % of shares outstanding	2.2%	0.3%	4.2%	1.1%	5.9%	1.5%	7.0%	2.9%

Table 4 also shows that there is no clear relationship between six-month returns from the IPO and the level of underpricing. However, insiders at firms with greater underpricing seem more likely to sell shares around the expiration of the lockup period. Further, when they sell, insiders at firms with greater underpricing seem to sell more shares. Our theory has no predictions for the relationship between underpricing, returns, and insider selling except through the effects of information momentum. We examine these relationships more systematically in Tables 5–8 in order to disentangle the effects of underpricing on our proxy for information momentum, research coverage, and the effects of research coverage on returns and insider selling.

We first investigate the relationship between IPO underpricing and research coverage. We correct for a potential selection bias in the IPOs for which First Call has analyst research coverage by estimating a Heckman two-stage model. The first stage is designed to explain why First Call has no research coverage for some firms (i.e., why the data are missing). It is estimated as a probit model with the dependent variable, *FirstCall*, equal to one if the firm is ever mentioned on First Call from the time of the IPO through one month following the lockup expiration and zero otherwise. The second stage examines the impact of underpricing on the level of research coverage, controlling for firm-specific characteristics. We measure the dependent variable, *Research*, in three ways. First, we define *Research* as the total number of mentions of the stock on First Call from the IPO through one month after the lockup expiration date. Second, we define *Research* as the number of recommendations made by non-lead underwriter analysts from the time of the IPO through one month following the lockup expiration. Third, we define *Research* as the number of recommendations made by lead underwriter analysts from the time of the IPO through one month following the lockup expiration. The estimation takes the form:

$$\begin{aligned} \textit{Stage 1}: \ \textit{FirstCall} = {} & \alpha + \beta_1 \log(\textit{MktCap}) + \beta_2\, \textit{LUR} + \beta_3\, \textit{Internet} \\ & + \beta_4\, \textit{VC} + \beta_5\, 3\textit{MoRet} + \mu_t + \varepsilon; \end{aligned} \tag{15}$$

$$\begin{aligned} \textit{Stage 2}: \textit{Research} = {} & \alpha + \beta_1 \log(\textit{MktCap}) + \beta_2\, \textit{LUR} + \beta_3\, \textit{Internet} \\ & + \beta_4\, \textit{Turnover} + \beta_5\, \textit{Co-Mgrs} + \beta_6\, \textit{UP} + \beta_7\, \textit{UP}^2 \\ & + \beta_8\, \textit{Lambda} + \varepsilon. \end{aligned} \tag{16}$$

In the first stage, the independent variables are: the log of the firm's market value of equity measured four weeks following the IPO in millions (Log(*MktCap*)), the lead underwriter rank (*LUR*), the three-month buy-and-hold raw return beginning on the day following the IPO (3*MoRet*), indicator variables for venture capital backed (*VC*) and internet firms, and calendar year indicators (μ_t).

In the second stage, we include a variable for the average amount of trading volume in the first month as a percent of the shares offered (*Turnover*) to control for the possibility that greater volume leads to greater research coverage. We also control for the number of co-Managers (*Co-Mgrs*) at the IPO. We expect that there is more research coverage when there are more underwriters involved at the IPO.

Table 5
IPO research coverage using Heckman two-stage estimation
The sample consists of 618 firms that completed an IPO between January 1994 and December 1999. The first stage probit model estimates the probability of receiving any research coverage. The second stage OLS estimations predict the level of research coverage correcting for the selection bias from the first stage. Research coverage is defined as the number of mentions on First Call, the number of recommendations made by non-lead underwriter analysts, and the number of recommendations made by lead underwriter analysts from the time of the IPO through one month following the expiration of the lockup. The independent variables included (in either stage) are an internet indicator variable, an indicator variable for venture capital-backed IPOs, the log of the market value of equity post-IPO, the rank of the lead underwriter, turnover (defined as the average daily trading volume in the first month of trading as a percentage of the shares offered in the IPO), the three-month buy-and-hold percentage return, the number of co-Managers at the IPO, underpricing, and underpricing squared. Calendar year indicators are included in the first stage but not reported. *p*-values are in brackets.

		Dependent variable	
	First Call mentions	Non- lead recommendations	Lead recommendations
Panel A: second-stage estimates			
Intercept	−13.426	−12.790	3.249
	[0.0001]	[0.0001]	[0.0024]
Log market value of equity	2.417	2.660	0.088
	[0.0001]	[0.0001]	[0.6776]
Lead underwriter rank	6.565	7.330	1.851
	[0.0011]	[0.0042]	[0.0470]
Internet indicator	2.889	2.155	0.841
	[0.0001]	[0.0058]	[0.0031]
Turnover	−4.702	−2.073	−0.949
	[0.1182]	[0.5897]	[0.4990]
Number of co-Managers at IPO	1.019	1.686	0.060
	[0.0001]	[0.0001]	[0.6174]
Underpricing	0.0333	0.0307	0.0027
	[0.0001]	[0.0008]	[0.4245]
Underpricing squared	−0.000036	−0.000036	−0.000005
	[0.0027]	[0.0193]	[0.3550]
Inverse mills ratio	−0.338	−1.510	−1.631
	[0.8271]	[0.4453]	[0.0224]
Adjusted R^2	39.55%	34.82%	7.35%

Panel B: First-stage estimates (probit model explaining when dependent variable in second stage is not missing)

The constant and coefficients on year indicators are not reported.	
Log of market value of equity	0.3431
	[0.0049]
Lead underwriter rank	1.9189
	[0.0001]
Internet indicator	−0.5343
	[0.0022]
Venture capital indicator	−0.1658
	[0.3354]
Three-month return	0.000
	[0.9611]
Observations	618
Prob > χ^2	[0.0000]

Table 6
Percentage returns from the IPO to the lockup expiration
The sample consists of 618 firms that completed an IPO between January 1994 and December 1999. The dependent variable is the buy-and-hold raw return from the end of the first day of trade following the IPO through six months post IPO. The independent variables included are six-month return on the NASDAQ Composite Index, the log of the market value of equity post-IPO, the rank of the lead underwriter, an internet indicator variable, a venture-capital indicator, an indicator equal to one if the firm is not covered by First Call, underpricing, underpricing squared, the number of co-Managers at the IPO, the number of times the stock is mentioned on First Call, and non-lead and lead underwriter analyst recommendations from the time of the IPO through one month following the lockup expiration. Calendar year indicators are included but not reported. None of the coefficients on the calendar year indicators are significant. *p*-values are in brackets.

	Six-month buy-and-hold return
Calendar year dummies	Yes
Intercept	−18.243
	[0.5003]
Nasdaq Composite Index return	2.660
	[0.0001]
Log of market value of equity post-IPO	1.742
	[0.8046]
Lead underwriter rank	5.530
	[0.0609]

Table 6 (*continued*)

	Six-month buy-and-hold return
Internet indicator	12.963 [0.1768]
Venture capital indicator	3.493 [0.7136]
No research coverage indicator	−15.344 [0.3615]
Underpricing	−0.078 [0.5256]
Underpricing squared	−0.00002 [0.4317]
Number of co-Managers at IPO	−18.299 [0.0001]
Number of mentions on first call	0.017 [0.8575]
Non-lead analyst recommendations	4.755 [0.0001]
Lead-underwriter analyst recommendations	−7.266 [0.0001]
Adj. R^2	28.64%

The independent variables of interest are the level of underpricing (UP) measured as the offer to open return and underpricing squared (UP^2). We include the squared term to test for concavity in the relationship between information momentum and underpricing, which we assumed in Section 2. We estimate the first stage using the full sample of 618 firms. The second-stage includes only the 519 firms with any level of research coverage on First Call.

The results are in Table 5. Focusing on the second stage estimates, the first two columns show that the number of mentions by research analysts following the stock on First Call and the number of non-lead analyst recommendations are significantly related to the level of underpricing. However, the third column shows that the number of lead analyst recommendations is unrelated to the level of underpricing, suggesting that underpricing the IPO is not necessary to attract the attention of the lead underwriters' analysts. This is consistent with the view that lead analyst recommendations are simply part of the service provided by the underwriter to firms going public. Another implication of the results in the third column is that lead

Table 7
Robustness of IPO research coverage and return results

The sample consists of 618 firms that completed an IPO between January 1994 and December 1999. The table contains two sets of estimations. The first three columns contain the second stage of a Heckman estimation predicting the level of research coverage (the first stage results are presented in Table 5). Research coverage is defined as the number of times the stock is mentioned on First Call and the number of recommendations made by non-lead and lead analysts from the time of the IPO through one month following the expiration of the lockup. The fourth column contains an OLS estimation relating month four to six returns following the IPO to research coverage. The independent variables included are the four- to six-month return on the NASDAQ Composite Index, the log of the market value of equity post-IPO, the rank of the lead underwriter, an internet indicator variable, a venture-capital indicator, an indicator equal to one if the firm is not covered by First Call, underpricing, underpricing squared, turnover (defined as the average daily trading volume in the first month of trading as a percentage of the shares offered in the IPO), the three-month buy-and-hold return, the number of co-managers at the IPO, the number of times the stock is mentioned on First Call, and non-lead and lead underwriter analyst recommendations from the time of the IPO through one month following the lockup expiration. None of the coefficients on the calendar year indicators are significant in the fourth column. *p*-values are in brackets.

	2nd stage of Heckman estimation			
	First Call mentions	Non-lead recommendations	Lead recommendations	Months four to six buy-and-hold return
Calendar year dummies	No	No	No	Yes
Intercept	−11.943 [0.0001]	−10.079 [0.0005]	3.080 [0.0139]	15.930 [0.4277]
Nasdaq Composite Index return				1.811 [0.0001]
Log of market value of equity post-IPO	2.088 [0.0001]	2.060 [0.0004]	0.123 [0.6104]	−11.306 [0.0315]
Lead underwriter rank	6.427 [0.0012]	7.078 [0.0044]	1.882 [0.0001]	5.194 [0.0174]
Internet indicator	2.868 [0.0001]	2.115 [0.0052]	0.848 [0.4632]	9.086 [0.1999]
Venture capital indicator				−1.846 [0.7930]
No research coverage indicator				−11.469 [0.3563]

Table 7 (*continued*)

	2nd stage of Heckman estimation			
	First Call mentions	Non-lead recommendations	Lead recommendations	Months four to six buy-and-hold return
Number of co-Managers at IPO	1.031 [0.0001]	1.708 [0.0001]	0.058 [0.9673]	−7.524 [0.0227]
Underpricing	0.0340 [0.0001]	0.0320 [0.0003]	0.0026 [0.9831]	−0.0261 [0.7726]
Underpricing squared	−0.000035 [0.0036]	−0.000033 [0.0265]	−0.000005 [0.9987]	−0.000032 [0.8362]
Turnover	−6.879 [0.0229]	−6.054 [0.1111]	−0.705 [0.0001]	
Inverse Mills ratio	−0.933 [0.5429]	−2.599 [0.1784]	−1.562 [0.0747]	
Three-month return	0.013 [0.0001]	0.024 [0.0001]	−0.002 [0.0001]	−0.012 [0.7744]
Number of mentions on First Call				0.041 [0.5671]
Non-lead analyst recommendations				2.354 [0.0001]
Lead-underwriter analyst recommendations				−2.833 [0.0282]
Adj. R^2	41.22%	38.63%	7.35%	25.09%

Table 8
Insider selling around the lockup expiration
The sample consists of 618 firms that completed an IPO between January 1994 and December 1999. The table examines shares sold by insiders in the period from two calendar months prior to two months following the expiration of the lockup provision. The first column provides a logit estimation of the probability of insider sales around the lockup expiration. The second column provides a Tobit estimation where the dependent variable, Total Sales (expressed in percentage points), is defined as shares sold by managers in the open market and shares sold by insiders in seasoned equity offerings divided by the total number of shares outstanding. The independent variables included are the log of the market value of equity measured post-IPO, the rank of the lead underwriter, an internet-related indicator, a venture capital-backed indicator, an indicator equal to one if the firm has no research coverage on First Call, underpricing, underpricing squared, short interest outstanding in the month of the lockup expiration expressed as a percent of total shares outstanding, the number of co-Managers on the IPO, the number of mentions on First Call, and non-lead and lead analyst recommendations. Calendar year indicators are also included but not reported. None of the coefficients on the year indicators are significant. *p*-values are in brackets.

	Logit model	Tobit model
The constant and coefficients on year indicators are not reported.		
Log of market value of equity post-IPO	0.1882	−0.3578
	[0.2003]	[0.1100]
Lead underwriter rank	−0.3919	0.5052
	[0.5266]	[0.6031]
Internet indicator	−0.2442	−0.2469
	[0.2201]	[0.4275]
Venture capital indicator	0.6214	1.2473
	[0.0016]	[0.0002]
No research coverage indicator	−0.7127	−1.5467
	[0.0520]	[0.0105]
Underpricing	0.0052	0.0038
	[0.1122]	[0.3015]
Underpricing squared	−0.000007	−0.000003
	[0.4148]	[0.4466]
Short interest at lockup expiration	0.1610	0.1003
	[0.0002]	[0.0351]
Number of co-Managers at IPO	−0.0705	0.0764
	[0.4947]	[0.7180]
First Call mentions	0.0011	−0.0043
	[0.5814]	[0.1909]
Non-lead analyst recommendations	0.0323	0.0528
	[0.0413]	[0.0210]
Lead-underwriter analyst recommendations	−0.0785	−0.1585
	[0.0255]	[0.0052]
Observations	618	618
Log likelihood	363.95	−165.39

underwriter analyst recommendations are not a mechanism through which information momentum operates.

For the number of mentions on First Call and the number of non-lead recommendations, the relationship between underpricing and research coverage is concave, as evidenced by the positive and significant coefficient on underpricing and the negative and significant coefficient on underpricing squared. This is consistent with the assumed concavity of the momentum generating function from the model. For non-lead analyst recommendations, greater underpricing (up to 852%) leads to greater research coverage. The number of non-lead analyst recommendations is maximized at underpricing of 426%. In our sample, the average level of underpricing is 50%. Underpricing an IPO by 50% yields an additional 1.44 ($=0.0307*50-0.000036*50^2$) non-lead analyst recommendations relative to no underpricing. These results are consistent with those in Rajan and Servaes (1997), who find that the number of analysts providing earnings estimates is positively associated with IPO underpricing.

The third implication that we test is whether stock returns from the IPO to the expiration of the lockup period are increasing in information momentum. We measure stock returns as the buy-and-hold return from the IPO's first-day closing price through 180 days following the IPO (*RET*). We estimate the following regression:

$$\begin{aligned} RET = {} & \alpha + \beta_1\, NAS + \beta_2 \log(MktCap) + \beta_3\, LUR + \beta_4\, Internet + \beta_5\, VC \\ & + \beta_6\, NoResCov + \beta_7\, UP + \beta_8\, UP^2 + \beta_9\, Co\text{-}Mgrs + \beta_{10}\, Mentions \\ & + \beta_{11}\, NonLeadRecs + \beta_{12}\, LeadRecs + \mu_t + \varepsilon. \end{aligned} \tag{17}$$

As additional control variables, we include the number of co-managers at the IPO (*Co-Mgrs*), the return on the Nasdaq Composite Index (*NAS*), and an indicator variable set to one if the firm has no research coverage on First Call (*NoResCov*).

Table 6 shows that research coverage defined as the number of mentions (*Mentions*) of the stock by brokers during the first six months from First Call is positive but insignificant in explaining six-month returns. The number of recommendations made by non-lead analysts (*NonLeadRecs*) is positive and significant in explaining six-month returns. The number of recommendations made by lead analysts (*LeadRecs*) is negative and significant in explaining six-month returns. The negative coefficient on the recommendations by lead analysts again suggests that lead analysts are not a mechanism through which information momentum operates, consistent with the results from the third column of Table 5. Instead, Michaely and Womack (1999) argue that the recommendations of lead underwriter-affiliated analysts are biased and thus less informative than those by non-lead analysts. The pattern of coefficients in Table 6 is consistent with this view.

We also control for the level of underpricing and underpricing squared. We find no independent effect of underpricing on returns. Consistent with the theory, these results suggest that underpricing affects returns through increased research coverage. Moreover, research coverage seems to matter positively primarily in the form of non-lead analyst recommendations, rather than the number of mentions on First Call.

From Table 5, mean underpricing of 50% yields an additional 1.44 non-lead analyst recommendations. An additional 1.44 non-lead analyst recommendations generates an incremental 6.85% ($=1.44*4.755$) six-month return in Table 6.

While these results are consistent with the theory, it is natural to wonder if reverse causality is generating the results. High returns after the IPO could cause analysts to follow the stock and therefore generate increased research coverage, rather than greater research coverage leading to higher returns. We address this issue in two ways. First, we examine whether returns do in fact explain research coverage. Research coverage occurs throughout the lockup period. If the alternative explanation is correct, it should be the case that returns shortly after the IPO explain research coverage. In Table 5, we include the three-month return as an independent variable in the first stage of our Heckman selection specification. The three-month return is not significant in explaining whether a firm receives research coverage on First Call.

It may still be the case that, conditional on receiving research coverage on First Call, firms with higher early returns receive more mentions and more non-lead and lead analyst recommendations. The first three columns of Table 7 report results for the second stage of our Heckman selection specification including three-month returns as an independent variable. In the first column, the dependent variable is the number of mentions on First Call. In the second column, the dependent variable is the number of non-lead analyst recommendations. In both specifications, the coefficient on three-month returns is positive and significant. Importantly, the underpricing variables are not affected. The coefficients on underpricing increase in magnitude and significance while the coefficients on underpricing squared decrease somewhat in absolute value. While some effect of returns on research coverage exists, underpricing appears more economically meaningful. In the third column, the dependent variable is the number of lead analyst recommendations. While the coefficient on three-month returns is negative and significant, the coefficients on the underpricing variables are insignificant, as in Table 5.

Second, as a robustness check for the results in Table 6, we examine whether research coverage continues to explain returns if we define returns over a shorter time period. We partition returns into two periods: from the end of trade on the first day following the IPO to the end of three months after the IPO (*3MoRet*) and from the beginning of the fourth month after the IPO to the end of the sixth month after the IPO (*4-6MoRet*). This second variable, *4-6MoRet*, is the dependent variable in the fourth column of Table 7, where we estimate a specification analogous to that in Table 6. In this specification, if the alternative explanation is correct, then the coefficients on research should not be significant. This is because the returns are measured after a substantial fraction of the research coverage has occurred (in the first three months after the IPO). We also include *3MoRet* as a control variable in this specification. The fourth column shows that research coverage in the form of non-lead analyst recommendations continues to be positive and significant in explaining four-to-six month returns. Furthermore, three-month returns are not significant in explaining four-to-six month returns. Lead analyst recommendations continue to be negative and significant, as in Table 6. This again is consistent with

bias explaining lead analyst recommendations rather than underpricing and information momentum. This specification implies that research coverage explains returns rather than returns explaining research coverage. Taken together, the results in Table 7 suggest that it is unlikely that reverse causality is generating our findings for non-lead analyst recommendations and returns.

The final implication of the model is that the level of insider selling around the lockup expiration is increasing in research coverage. We estimate the following logit and Tobit specifications:

$$\begin{aligned} Sales = {} & \alpha + \beta_1 \log(MktCap) + \beta_2\, LUR + \beta_3\, Internet + \beta_4\, VC + \beta_5\, NoResCov \\ & + \beta_6\, UP + \beta_7 UP^2 + \beta_8\, SI + \beta_9\, Co\text{-}Mgrs + \beta_{10}\, Mentions \\ & + \beta_{11}\, NonLeadRecs + \beta_{12}\, LeadRecs + \mu_t + \varepsilon. \end{aligned} \tag{18}$$

In the logit specification, the dependent variable, *Sales*, equals one if there are any stock sales by insiders in the period from two months prior to the expiration of the lockup through two months following the expiration. This can occur either in the open market or through underwritten block transactions in seasoned equity offerings. In the Tobit specification, the dependent variable, *Sales*, is defined as the amount of stock sold by insiders in the period from two months prior to the expiration of the lockup through two months following the expiration divided by the total shares outstanding. Table 8 contains the results.

We include an additional control variable for the amount of short interest outstanding as a percentage of shares outstanding in the month of the lockup expiration (*SI*). Short sale constraints might explain why there are large price drops around lockup expirations. Prior to the additional supply being released by insider sales or seasoned equity offerings there may be insufficient shares outstanding for arbitrageurs to short. As a result, the price at lockup expiration could be artificially high due to a lack of liquidity. Artificially high prices could induce insiders to sell at the expiration of the lockup period. We include short interest in our insider selling regressions to control for this possibility.

Consistent with the theory, we find that insider selling around the lockup expiration is increasing in the number of recommendations made by non-lead underwriter analysts. The number of First Call mentions has no incremental explanatory power for either the likelihood or the number of shares sold around the lockup expiration, consistent with the results in Table 6. The number of recommendations by lead underwriter analysts has a negative and significant effect on the probability and level of insider selling, also consistent with the results in Table 6. In addition, firms with greater short interest outstanding at the expiration of the lockup period have greater insider selling. Consistent with the theory and the results in Table 6, underpricing and underpricing squared do not have an independent effect on insider selling. Finally, an additional 1.44 non-lead analyst recommendations (from underpricing of 50%) leads to incremental insider selling of 0.076% ($=1.44*0.0528$) of the firm's equity outstanding around the expiration of the lockup period. The average firm in our sample has 26,938,000 shares outstanding, so

the incremental number of shares sold is 20,482. This is about 3.9% of the unconditional average of 526,961 shares sold by insiders at the lockup expiration.

5. Discussion and conclusion

We develop a model in which managers strategically underprice new issues. Underpricing creates information momentum, which shifts the demand curve for the firm's stock outwards. This generates higher prices at the lockup expiration, when managers have their first opportunity to sell shares. As a result, managers accept substantial underpricing in order to maximize their personal wealth. The key condition for our model is that the value of information momentum must be sufficiently high so as to significantly shift out the demand curve for a new issue. Intuitively, we think such a condition is likely to be met in hot IPO markets or in industries that are perceived to be hot, such as internet-related firms. Significant underpricing enables these firms to catch the attention of the media and research analysts, who can follow only a limited number of stocks. Conversely, when the value of information momentum is low, as in cold IPO markets or in industries that are not perceived to be hot, there will be little benefit to substantial underpricing.

Our empirical results are that managerial shareholdings are positively correlated with first-day underpricing. We also show that underpricing is positively correlated with non-lead analyst research coverage. This research coverage is positively correlated with stock price performance through the lockup expiration and with insider selling at the expiration of the lockup.

There are several potential alternative explanations for our findings. First, owner–manager risk aversion is a possible explanation for why firms want to underprice. More risk-averse managers will underprice more in order to ensure that the IPO is successful. These are also the managers who will want to sell more at the expiration of the lockup in order to diversify their holdings. This explanation is silent as to why analyst recommendations are correlated with the number of shares sold at the lockup expiration. It also suggests that risk-averse managers should sell shares in the IPO and not underprice. Manager selling is not a predominant feature of most IPOs. While there is very weak evidence (in Table 3) that IPOs in which insiders sell secondary shares are underpriced less, this does not seem to be a full explanation since few insiders sell initially. Lastly, the observation that risk-averse managers should sell more at the expiration of the lockup is somewhat at odds with the usual characterization of entrepreneurs as risk-takers.

A second possibility is asymmetric information. Welch (1989) argues that high quality firms will underprice the IPO in order to get better prices for seasoned offerings. His model can also apply to insider sales in that high quality firms underprice the IPO so that insiders can get better prices at the expiration of the lockup. However, asymmetric information does not explain cross-sectional variation in the number of shares sold at the expiration of the lockup. In the separating equilibrium of Welch's model, the information about firm quality is revealed at the time of the IPO. Thereafter, managers from all types of firms can sell their own

shares at the true value of those shares. As a result, there is no reason why managers of high quality firms would sell more shares at the lockup expiration than would managers of low quality firms. Our model explains why managers at firms that underprice more generate more research coverage, pushing up the stock price and leading them to sell more shares at the expiration of the lockup.

Third, Chemmanur (1993) argues that owner–managers of high quality firms will underprice the IPO in order to compensate investors for gathering information about the firm. Low quality firms pool with the high quality firms, and then are more likely revealed as low quality through the production of information. A high quality firm is more likely revealed as high quality, allowing managers to sell shares in a secondary offering at closer to the firm's true value. A key empirical implication of Chemmanur's (1993) model is that greater underpricing is associated with lower gross proceeds from the IPO. In Table 3, the correlation between IPO proceeds and underpricing is insignificant. By contrast, if information momentum is important, then underpricing is associated with greater managerial shareholdings (or option holdings). Table 3 supports this intuition.

While there may be alternative explanations for some of our results, we are not aware of an alternative that explains all four of our findings. We find that (1) greater managerial share and option holdings lead to greater underpricing, (2) first-day underpricing creates information momentum as proxied by greater research coverage by non-lead analysts, (3) greater research coverage leads to positive stock returns to the lockup expiration, and (4) insiders sell more stock at lockup expiration when research coverage is higher. Our evidence is consistent with managers strategically underpricing their IPOs in order to maximize their personal wealth from selling shares at the expiration of the lockup period.

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