Leaders and Followers in a Hot IPO Market*

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Abstract

We model IPO timing decisions of firms. Our model's outcome suggests that leaders in hot markets are likely to have better growth opportunities, and that they may have to underprice their shares to signal their quality to investors. This implies that, within a hot market, average underpricing should be high initially, but should fall later on sharply. Indeed, while average underpricing is 34.24% in the first quarter of a hot market, it falls down to 17.59% in the second quarter and remains low in the remaining quarters. Moreover, firms that lead hot markets grow faster ex post, which is consistent with them having better growth opportunities. Overall, our model and empirical findings have broad implications for the literature on hot IPO markets.

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1 Introduction

The literature on initial public offerings (IPO) documents that both the IPO volume (i.e., number of firms going public in a month, quarter, etc.) and the IPO underpricing (i.e., average initial returns of IPOs in a month, quarter, etc.) vary substantially over time. Moreover, periods of high IPO volume tend to overlap with periods of high IPO underpricing causing "hot" markets to emerge.[1]

There is a large number of papers that compare IPOs that take place in hot versus cold markets. For instance, Alti (2006) argues that hot markets are temporary windows of opportunities during which cost of equity is low. He shows that hot IPOs raise significantly more equity than cold IPOs. Another example is Helwege and Liang (2004), who compare hot and cold IPOs in terms of operating characteristics. They find that, consistent with the market timing explanation, the differences are not significant.

This type of papers has a limitation in that they ignore the possibility of variation in conditions *within* a hot market. Hot markets can easily last more than a year. Therefore, there is no reason to believe that firms that went public in the first few months of a hot market have the same incentives and/or characteristics as those that conducted an IPO much later in that market. There is now a nascent literature on IPO timing decisions of firms within a hot market (see Chemmanur and He (2011) and Çolak and Günay (2010)).

In this paper we model IPO timing decisions of private firms within a hot market. We assume that some firms have more valuable growth opportunities than others. Our model's outcome suggests that, when the IPO market is in a signaling equilibrium, these firms lead hot markets. Moreover, they underprice their issues in order to signal their quality to investors. This outcome has various empirical implications. The two most significant ones are: (1) IPO underpricing should be high at the start of a hot

[1] See Ibbotson and Jaffe (1975) and Ritter (1984) for early research on hot markets. For more recent research on IPO cycles see Lowry and Schwert (2002), Lowry (2003), Pastor and Veronesi (2005) and Yung, Colak, and Wang (2008).

market and then should fall sharply, (2) firms that go public early in a hot market should grow faster ex post.

We test these two implications and other related ones on a large sample of US IPOs. We find that average underpricing in the first quarter of a hot market is 34.24%, while the corresponding figure for the second quarter is only 17.59%. Therefore, after the first quarter, average underpricing almost halves. In the remaining quarters, average underpricing falls further and remains low, close to its level in cold markets. Moreover, we find evidence that assets, sales, capital expenditures and EBITDA of leaders grow faster one year after their IPOs compared to their pre-IPO levels.

Our paper contributes to the literature on hot IPO markets. It shows that the average underpricing is far from being uniform during the course of a hot market. It is initially very high, but then falls very sharply. It also shows that firms that lead hot markets grow faster ex post. Both of these findings are consistent with our IPO timing model, which provides a rational explanation for IPO timing and underpricing within a hot market. Overall, our paper's central message is that future research should take into account the systematic difference between early and late IPOs in a hot market. Our model and empirical evidence suggest that IPO waves can be led by high-quality firms.

The recent work by Chemmanur and He (2011) and Çolak and Günay (2010) have also implications about IPO timing within a hot market. Our results complement those by Chemmanur and He (2011), who find that firms that lead IPO waves have higher productivity and post-IPO profitability. Çolak and Günay (2010)'s model suggests that some high-quality firms may strategically delay their IPOs. They find that firms in the highest-quality decile wait longer before going public. However, their main quality measure is long-run abnormal returns. They do not investigate IPO firms' growth opportunities at the time of going public and their ex-post growth, which are central to our model and tests. Moreover, neither of these two papers focuses on IPO underpricing, which is a hallmark of hot markets. Therefore, our paper adds to the literature by treating IPO timing within hot markets and IPO underpricing as two sides of the same coin.

Our paper is also related to the strand of literature that views underpricing as a "money-burning" signal by high-quality issuers. The premise of this view is that high-quality issuers recoup the cost of underpricing in the *secondary market*, for instance when they conduct seasoned equity offerings (SEO).[2] The novelty in our model is that firms reap the benefits of signaling immediately. In other words, our model shows that underpricing can be used as a tool for signaling, even if high-quality IPO firms do not plan to conduct any SEOs in the near future. This is relevant to the literature, since the evidence on the link between IPO underpricing and subsequent SEO is weak (see Jegadeesh, Weinstein, and Welch (1993), Michaely and Shaw (1994) and Kennedy, Sivakumar, and Vetzal (2006)).[3]

Finally, our model provides a theoretical basis for the lead-lag relationship between IPO underpricing and IPO volume. Lowry and Schwert (2002) show that high IPO underpricing leads to high IPO volume. This is rather puzzling, since we would expect less firms to go public after observing periods of high underpricing, considering that underpricing is an indirect cost of going public. Lowry and Schwert (2002) argue this relationship might be due to releases of positive information, which is not fully incorporated into offer prices, hence the high levels of current underpricing and future volume. On the other hand, our model suggests that the driving factor behind both underpricing and volume is improvements in market conditions. Indeed, we show that once we control for this factor, the lead-lag relationship disappears. This idea is in the spirit of Pastor and Veronesi (2005), who also argue that changes in market conditions is one of the main drivers of IPO waves. However, they do not investigate the relationship

[2] See Allen and Faulhaber (1989), Grinblatt and Hwang (1989), Welch (1989) and Welch (1996) for signaling models of IPO underpricing.

[3] Recently, Francis, Hasan, Lothian, and Sun (2010) have shown that there is a link between foreign IPOs and subsequent SEO activity abroad for firms "domiciled in countries with segmented markets".

between underpricing and volume.

The remainder of our paper is organized as follows. First, we present our IPO timing model in Section 2. Then, we develop testable hypotheses based on our model in Section 3 and provide the test results in Section 4. Section 5 concludes.

2 Model

We consider an economy with two dates: $t \in \{0, 1\}$. There is uncertainty about the state of economy at $t = 1$, such that it can be good with probability q or bad with probability $1 - q$. At $t = 0$, private firms have growth opportunities that pay off V if the economy turns out be good at $t = 1$, and zero otherwise. A private firm is of high quality with probability p or of low quality with probability $1 - p$, such that high-quality firms have more valuable growth opportunities $V_g > V_b$.[4] All projects require an irreversible investment of I and firms can finance this investment by selling a fraction of their equity to investors during their IPOs. After going public, firms retain fraction α of their equity. The cost of going public is c. The IPO market is competitive and investors are uninformed, such that they cannot distinguish high- and low-quality firms. For simplicity, the discount rate for payoffs at $t = 1$ is assumed to be zero.

The economic uncertainty gives firms an incentive to wait. If a firm invests at $t = 0$ and the economy turns out to be bad at $t = 1$, the payoffs are $-c$ and $-I$ for the firm and investors respectively. On the other hand, the parties can avoid sinking the issuing and investment costs, if the firm waits at $t = 0$ and goes public at $t = 1$ only if the economy is good. In other words, in our model, firms have a real option to go public, which can be kept alive at $t = 0$ and exercised at $t = 1$ depending on the state of the economy. This might give the impression that our model's outcome is obvious, such that all firms would choose to wait at $t = 0$. However, such an impression is false, since

[4] From this point we refer to a private firm simply as "firm", with the understanding it is private unless otherwise stated.

(as we show next) the asymmetric information about firm quality gives high-quality firms an incentive to move at $t = 0$.

2.1 Outcome

Our model can lead to three different types of equilibrium: (1) pooling equilibrium: all firms go public at the same date, (2) separating equilibrium: high- and low-quality firms go public at different dates, (3) signaling equilibrium: high- and low-quality firms go public at different dates, and high-quality ones send a costly signal to investors by underpricing their issues.

All firms have an incentive to wait due to the economic uncertainty. On the other hand, high-quality firms have an incentive to move to distinguish themselves from low-quality firms. Interestingly, high-quality firms' incentive to move can give low-quality firms an incentive to move as well, since they can benefit from mimicking high-quality firms. Thus, the type of equilibrium in IPO market depends the tradeoff between firms' incentives to wait and to move.

Before moving on to our propositions, we define the average firm value at $t = 1$ when the economy is good, since this variable helps simplify the notation:

$$\overline{V} \equiv pV_g + (1 - p)V_b$$

Proposition 1 *For $0 \leq q \leq \underline{q}$, the IPO market is in a pooling equilibrium, such that all firms wait at $t = 0$ and go public at $t = 1$ only if the economy is good, where:*

$$\underline{q} = \frac{I + c}{(V_g/\overline{V})I + c} \tag{1}$$

The equity stake firms retain after their IPOs is:

$$\alpha_p = 1 - \frac{I}{\overline{\overline{V}}} \tag{2}$$

Proof. See Appendix A ■

If the economy is likely to be bad, no firm would want to move at $t = 0$, even if they would be valued as high-quality firms by investors. Consequently, all firms wait at $t = 0$ and go public at $t = 1$ only if the economy is good. α_p reflects the average firm value, such that the IPOs are fairly priced on average at $t = 1$. When q exceeds $\underline{q}$, the pooling equilibrium breaks down, since it becomes optimal for high-quality firms to deviate from this equilibrium.

Proposition 2 *For $\underline{q} < q \leq q^*$, the IPO market is in a separating equilibrium, such that high-quality firms move at $t = 0$, while low-quality ones wait at $t = 0$ and go public at $t = 1$ only if the economy is good, where:*

$$q^* = \frac{(V_b/V_g)I + c}{I + c} \tag{3}$$

At $t = 0$, high-quality firms retain:

$$\alpha_g = 1 - \frac{I}{qV_g} > \alpha_p \tag{4}$$

and at $t = 1$, bad firms retain:

$$\alpha_b = 1 - \frac{I}{V_b} \tag{5}$$

Proof. See Appendix A ■

When $\underline{q} < q \leq q^*$, q is sufficiently high for high-quality firms to move, but not high enough for low-quality firms to mimic high-quality ones. Consequently, high-quality firms lead and low-quality ones follow if the economy turns out to be good. α_g and α_b reflect the true values of high- and low-quality firms, such that each IPO is fairly priced. Note that high-quality firms enjoy a better valuation in separating equilibrium, since $\alpha_g > \alpha_p$. This is precisely the reason why they move, despite the uncertainty about the value of their growth opportunities. As soon as q exceeds q^*, however, it becomes optimal for low-quality firms to mimic high-quality ones, and the separating equilibrium breaks down.

Proposition 3 *For $q^* < q \leq \overline{q}$, the IPO market is in a signaling equilibrium, such that high-quality firms move at $t = 0$ and underprice their issues, while low-quality ones wait at $t = 0$ and go public at $t = 1$ only if the economy is good, where:*

$$\overline{q} = \frac{c}{(pV_g/\overline{V})I + c} \tag{6}$$

At $t = 0$, high-quality firms retain:

$$\alpha_u = \alpha_b + \frac{(1-q)c}{qV_b} < \alpha_g \tag{7}$$

and at $t = 1$, low-quality firms retain α_b.

Proof. See Appendix A ■

When $q^* < q \leq \overline{q}$, high-quality firms still move at $t = 0$, but they now have to underprice their issues just enough in order to deter low-quality firms from mimicking them. Consequently, unlike in separating equilibrium, high-quality firms no longer receive a fair valuation (i.e., $\alpha_u < \alpha_g$). But, even though their issues are underpriced, their valuation in signaling equilibrium is still sufficiently better than the valuation they would have got in pooling equilibrium (i.e., $\alpha_u > \alpha_p$). The problem is that $\partial\alpha_u/\partial q < 0$. That is, high-quality firms have to underprice their issues more as q increases. Consequently, when q exceeds $\overline{q}$, the signaling equilibrium becomes unsustainable. Above this threshold, high-quality firms prefer pooling with low-quality firms rather than underpricing their issues heavily.

Proposition 4 *For $\overline{q} < q \leq 1$, the IPO market is back in a pooling equilibrium, such that all firms wait at $t = 0$. All firms retain fraction α_p of their equities after their IPOs.*

Proof. See Appendix A ■

If the economy is likely to be good, high-quality firms no longer have an incentive to move at $t = 0$. This is because, they know that low-quality firms have a strong incentive to mimic them if they move, and they could deter low-quality firms only by underpricing their issues heavily, which turns out to be a worse option than pooling with low-quality firms at $t = 1$. Consequently, all firms wait at $t = 0$ and go public at $t = 1$ only if the economy is good. α_p reflects the average firm value, such that the IPOs are fairly priced on average.

2.2 Discussion

We illustrate our model's outcome in Figure 1. For $0 \le q \le \underline{q}$ and $\overline{q} \le q \le 1$, the IPO market is in a pooling equilibrium (the white regions). For $\underline{q} < q \le q^*$, it is in a separating equilibrium (the black region), and for $q^* < q \le \overline{q}$, it is in a signaling equilibrium (the gray region). Several points are worth noting about our model's outcome:

1. In a separating equilibrium, high-quality firms can signal their quality solely by taking the risk of going public early before the economic uncertainty is resolved. They do not have to underprice their issues in addition to taking this risk. However, for reasonable sets of parameter values, separating equilibrium exists in a very narrow region. This is clearly visible in Figure 1. This implies that, empirically, the IPO market should be far more likely to be either in a signaling or in a pooling equilibrium.

2. For the IPO market to be in a signaling equilibrium, the following conditions should hold: (1) the number of high-quality firms should be low relative to the number of low-quality ones (i.e., p should be low) and the quality wedge between the two types of firms should be sufficiently high (i.e., V_g/V_b should be large), (2) the future state of economy should be uncertain (i.e., q should be neither too low nor too high). The reason why these two conditions are necessary is as follows. High-quality firms receive a

particularly poor valuation in pooling equilibrium when the first condition holds. This gives them a strong incentive to signal their quality. However, the first condition is not sufficient for a signaling equilibrium. High-quality firms would not lead hot markets if the economy is highly likely to be bad. Interestingly, they would not lead them if the economy is highly likely to be good either, since this would require heavy underpricing to deter low-quality firms from mimicking. Therefore, economic uncertainty is essential for this type of equilibrium to exist. These two conditions imply that, empirically, the IPO market is most likely to be in a signaling equilibrium when, within the cohort of private firms ready to go public, a small proportion of firms has much better growth opportunities than the rest, and when there is significant uncertainty about the future state of economy.

3. Finally, the most important point about our model's outcome is the following. In a pooling equilibrium the *average* IPO is fairly priced; and in a separating equilibrium, which is empirically unlikely, *each* IPO is fairly priced. On the other hand, in a signaling equilibrium, IPOs of high-quality firms are underpriced, whereas those of low-quality firms are fairly priced. Moreover, in this type of equilibrium, high-quality firms lead hot markets, while poor-quality ones follow if the economy turns out to be good. Therefore, our model provides a rational framework in which high-quality firms can issue underpriced shares in equilibrium. Unlike the extant signaling models of underpricing in the literature, high-quality firms reap the benefits of their costly signal when they go public (not later on in the secondary market) by receiving a better valuation compared to the one they would get in pooling equilibrium. Our model also implies that, within a hot market that is in signaling equilibrium, a sharp fall in underpricing occurs when high-quality firms are followed by low-quality ones.

2.3 A numerical example of signaling equilibrium

Suppose that the IPO market is in a signaling equilibrium and consider a high-quality firm that goes public at $t = 0$. The high-quality firm retains fraction α_u of its equity in a signaling equilibrium, while it would retain α_g of its equity in a separating equilibrium. The crucial point is that $\alpha_u < \alpha_g$. That is, in a signaling equilibrium, the high-quality firm accepts to retain a less-than-fair fraction of its equity in order to signal its quality. In other words, it relinquishes too much equity to investors $1 - \alpha_u > 1 - \alpha_g$ in return for obtaining I. Then, the issue's underpricing in percentage points is:

$$\left(\frac{1-\alpha_u}{1-\alpha_g} - 1\right) \times 100$$

Plugging in the definitions of α_g and α_u from Equations (4) and (7) yields:

$$\left(\frac{V_g}{V_b}(q - (1-q)\frac{c}{I}) - 1\right) \times 100 \qquad where\ q^* < q \leq \overline{q} \tag{8}$$

This suggests that underpricing is linearly increasing in q. This is no surprise, since as q increases low-quality firms become more willing to mimic high-quality ones, so high-quality firms have to underprice more to deter low-quality firms from pooling with them. Apart from q, underpricing depends on V_g/V_b and c/I.

In order to provide a numerical example of signaling equilibrium, we need to choose parameter values for V_g/V_b, c/I, and p. Welch (1996) estimates that high-quality firms are 2 to 3 times more valuable than low-quality firms. Therefore, the parameter values we try for V_g/V_b are 2, 2.5, and 3. Lee, Lochhead, Ritter, and Quanshui (1996) report that the direct issuance costs are about 11% of the proceeds on average. We should also take into account other costs of going public, such as the entrepreneur's loss of private benefits (Benninga, Helmantel, and Sarig (2005)) and the opportunity cost of the management's time spent on preparing the firm for an IPO. Consequently, for c/I, we try 10%, 15%, and 20%. For p, we have to try small values, since signaling equilibrium is most likely to exist when the number of high-quality firms is low relative to the number of low-quality firms (see Section 2.2). Consequently, we try 2.5%, 5%, and 7.5%.

Table 1 shows the range of q values in which the IPO market is in a signaling equilibrium and the range of underpricing figures high-quality firms have to bear in order to signal their quality, given the parameter values above. As an example, for the scenario in the middle ($p = 5\%$, $V_g/V_b = 2.5$, and $c/I = 15\%$), the IPO market is in a signaling equilibrium when $q \in (0.48, 0.56)$. The magnitude of underpricing high-quality firms have to bear ranges between 0% (when $q = 0.48$) and 24.45% (when $q = 0.56$).

The figures in Table 1 makes it clear that the IPO market is unlikely to be in a signaling equilibrium when p is not low. In Panel C, even when p is only 7.5%, the range of feasible q values is quite narrow and in some cases the IPO market is never in a signaling equilibrium.

Overall, this numerical example indicates that for plausible values of V_g/V_b and c/I, and given that p is low, the IPO market is in a signaling equilibrium when the economic uncertainty is high (i.e., q is not close to 0 or 1).

3 Testable Hypotheses

According to our model, the IPO market equilibrium switches between pooling and signaling equilibria. During periods of high economic uncertainty, if the number of high-quality firms is low relative to the number of low-quality ones and if the quality gap between high- and low-quality firms is wide, the IPO market is likely to be in a signaling equilibrium. At other times it is in a pooling equilibrium.

A hot market that is in a pooling equilibrium is monotonous in the sense that average firm quality should be constant and average underpricing should be low throughout this market. On the other hand, a hot market that is in a signaling equilibrium is exciting, since average firm quality and average underpricing should be both high in the beginning of this market and they should both fall sharply later on in the same market. Overall, in a cross-sectionally pooled sample of hot markets, even if only one hot market is in a signaling equilibrium, we should observe that average firm quality and average underpricing are both higher at the start of a hot market.

Theoretically speaking, average underpricing should be positive at the start of a hot market and zero later on. Empirically, we expect to observe a smoother pattern, such that average underpricing rises steadily from a base level at the start of a hot market and declines rapidly back to its base level as the hot market ensues.[5]

$H1$: Average underpricing is higher at the start of a hot market.

Our model suggests that, in a signaling equilibrium, a firm's type is revealed to investors as soon as it goes public. Then, high-quality firms should have higher market to book ratios (a proxy for the value of growth opportunities) in their IPO years, since their underpriced issues signal investors that their growth opportunities are more valuable. Overall, since high-quality firms lead hot markets, the average market to book ratio should be higher initially within a hot market.

H2: Average market to book ratio is higher at the start of a hot market.

If investors could distinguish high-quality firms from low-quality ones using publicly available information at the time of firms' IPOs, the former type of firms would not need to lead hot markets and underprice their issues. Therefore, pre-IPO observable characteristics of leaders and followers should not be significantly different.

H3: Investors cannot predict which firms will become leaders in hot markets using data on pre-IPO firm and issue characteristics.

[5]The base level suggests that firms might have to issue underpriced shares for various other reasons (see e.g. Ritter (2003)) as well as signaling their quality to investors.

On the other hand, leaders should experience significantly stronger growth ex-post, owing to their superior growth opportunities.

> H4: Firms that lead hot markets experience significantly stronger post-IPO growth.

Our model also has implications about the time series behavior of IPO underpricing and volume. To understand these implications let's assume that q, the probability that the economy is good at $t = 1$, is a function of time: $q(t)$. We argued that when $q(t)$ is low, the IPO market is in a pooling equilibrium such that all firms wait at $t = 0$. In this case, a hot market is unlikely to emerge, since the economy is likely to be bad at $t = 1$. But, as $q(t)$ rises hot markets become more likely to emerge. Furthermore, when $q^* < q(t) \leq \bar{q}$, $q(t)$ is sufficiently high such that high-quality firms take the risk of going public at $t = 0$ and underprice their shares to prevent low-quality firms from imitating them. At $t = 1$, low-quality firms follow if the economy is good. Therefore, improvements in market conditions (i.e. $\delta q(t) > 0$), proxied by returns on a stock market index, have a tendency to cause higher underpricing and higher volume in an IPO market.

> H5: Monthly average underpricing and monthly IPO volume are both positively related to the previous month's return on a stock market index.

We have noted in Section 2.2 that signaling equilibrium works when the number of high-quality firms is low relative to the number of low-quality ones. This implies that periods of high underpricing in which small numbers of high-quality firms go public tend to be followed by periods of high volume in which large numbers of low-quality firms conduct their IPOs. This would create an empirical lead-lag relationship between average IPO underpricing and aggregate IPO volume, which is documented by Lowry and Schwert (2002). However, it is not the increase in average underpricing per se that causes an increase in subsequent aggregate volume. Both of these increases are driven by improvements in market conditions. As market conditions improve such that $q(t)$ rises to a level between q^* and $\overline{q}$, high-quality firms go public creating a period of high average underpricing, which is followed by a period high aggregate volume if low-quality firms follow. This suggests that there is a positive correlation between current average underpricing and future IPO volume, but this correlation is spurious and should disappear once the change in market conditions, the confounding factor, is controlled for.

> H6: Monthly IPO volume is not related to the average underpricing of previous months, when the previous month's return on the stock market index is controlled for.

4 Tests

Our empirical tests are conducted in IPO time (see e.g., Alti (2006)). We define the fiscal year y during which a firm goes public as the firm's IPO year and set it equal to 0. Then, the fiscal year that precedes (succeeds) the IPO year is set equal to -1 (+1), and so on.

We use the method of Yung, Colak, and Wang (2008) to identify the hot markets that took place within our sample period. In particular, we compare the 4-quarter moving average IPO volume $ma(4)$ of each quarter with the historical average in all previous quarters. Then, we classify a quarter as "hot" ("cold") if its $ma(4)$ exceeds (falls short of) the historical average by 50%. The remaining quarters are classified as "warm". Moreover, in order to alleviate the concerns about a potential nonstationarity of quarterly IPO volume (see Lowry (2003)), we deflate the number of IPOs in each quarter by the total number of public firms in the previous quarter before calculating the $ma(4)$.[6]

[6] Public firms are defined as those that have a sharecode of 10 or 11 in CRSP (see Pastor and Veronesi (2005)). The augmented Dickey-Fuller test rejects the null hypothesis that the deflated quarterly IPO

Figure 2 illustrates the hot markets we identified between 1975 and 2010. The data on aggregate IPO volume is obtained from Jay Ritter's website.[7] We use the "net count" variable, which excludes penny stocks, units, closed-end funds, REITs acquisition companies, ADRs, limited partnerships, banks and S&Ls, and IPOs not listed on CRSP. The data on this variable is available from 1975. The area plot in the figure represents $ma(4)$. The black, dark gray, and light gray areas represent hot, warm, and cold markets respectively. The line plot is the historical average prior to each quarter. Overall, there are 7 different hot markets during our sample period that last between 4 and 14 quarters.

Once the hot markets are identified, we determine the position of each firm that goes public during or immediately before a hot market. More specifically, if a firm went public within the qth quarter of a hot market, we set its position equal to $Q = q$, where $q \geq 1$. The positions of firms that conducted an IPO during a quarter that immediately precedes a hot market are set equal to $Q = 0$.

4.1 Data

Our dataset, which is obtained from Securities Data Company (SDC), contains 11,139 common share IPOs that took place in the U.S. between January 1st, 1975 and December 31st, 2010. We construct our initial sample from this dataset by dropping IPOs by financial firms (2,605 observations), reverse leveraged buyouts (337 observations), spinoffs (571 observations), IPOs with an offer price less than \$1 (145 observations), IPOs that have duplicate CUSIP codes (22 observations), and unit offers (955 observations).[8] Consequently, there are 6,504 observations in our initial sample. 4,610 of these observations belong to hot markets. 1,708 of them belong to warm markets, and the remaining 186 to cold markets.

volume time series contains a unit root at 1% significance level.

[7] http://bear.warrington.ufl.edu/ritter/ipoisr.htm

[8] Our sample selection criteria are similar to those employed by Helwege and Liang (2004).

We get the data on offer prices, primary and secondary shares, total proceeds, and venture capital backing from the SDC. We obtain the first trading day closing prices from the Center for Research in Securities Prices (CRSP). We drop observations if the trading date is 2 days earlier or 10 days later than the IPO date. We collect financial data from Compustat. Finally, we get the firm foundation years from the Field-Ritter dataset.[9] In our final sample there are 5,502 observations. The numbers of observations for hot, warm, and cold markets in the final sample are 3,843, 1,487, and 172 respectively.

The variables that we use in our empirical analysis are defined as follows. $IniR$, our underpricing measure, is the initial percentage return between the offer price and the first trading day closing price. $TPro$ is the total proceeds as a percentage of total assets in $y = 0$. $SecS$ is the number of secondary shares offered as a percentage of total shares offered. $VCap$ is a dummy variable equal to 1 if the IPO is backed by a venture capital firm. Age is the difference between the firm's IPO and foundation years. $MtoB_0$ is the firm's market to book ratio following its IPO in $y = 0$. It is equal to long-term debt in $y = 0$ plus market equity in $y = 0$ (the number of shares outstanding times the share price) divided by total assets in $y = 0$. $Sales_i$ and $Assets_i$ are net sales and total assets measured in millions of 2010 dollars in $y = i$ respectively. $CapX_i$ is capital expenditures, $Prof_i$ is EBITDA, $Debt_i$ is long-term debt in $y = i$ as a percentage of total assets in $y = i$.

4.2 Descriptive statistics

Firms that go public in a cold quarter are underpriced by 12.28% on average. As the IPO market heats up, the level of average underpricing starts to increase. IPOs are underpriced on average by 18.44% in warm quarters and by 29.68% in quarters that immediately precede a hot market $Q = 0$. The level of average underpricing

[9] See Jay Ritter's website: http://bear.warrington.ufl.edu/ritter/FoundingDates.htm

reaches its peak level of 34.24% in the first quarters of hot markets $Q = 1$. Then, it falls sharply to 17.59% in the second quarters of hot markets $Q = 2$. That is, average underpricing almost halves after the first quarter of a hot market. The average underpricing continues to decrease, such that firms that go public after the fifth quarter of a hot market are underpriced by 12.58% on average, which is almost identical to the level of average underpricing in cold quarters. This pattern, which is illustrated in Figure 3a, is consistent with $H1$. Average underpricing rises at the start of a hot market when high-quality firms go public, and it falls sharply when low-quality firms follow.

Figure 3b shows that average market to book ratio of IPO firms in $y = 0$ follows an identical pattern to average underpricing. This is consistent with $H2$, because investors rationally believe that growth opportunities of leaders are more valuable. Therefore, average $MtoB_0$, like average $IniR$, rises initially when high-quality firms lead and then falls back sharply when low-quality firms follow.

Figure 3 makes it clear that the IPOs in $Q = 0$ and $Q = 1$ are substantially different than the remaining IPOs in terms of their average levels of underpricing and market to book ratios. Therefore, for the rest of our analysis, we classify a firm that conducts an IPO in $Q = 0$ or $Q = 1$ as a "leader" and a firm that goes public withing a later quarter of a hot market $Q > 1$ as a "follower". More specifically, we define a dummy variable L as follows:

$$L = \begin{cases} 1 & 0 \leq Q \leq 1 \\ 0 & Q > 1 \end{cases} \tag{9}$$

Table 2 provides descriptive statistics for our sample. We analyze the Nasdaq Bubble quarters (the last quarter of 1999 and the first quarter of 2000) separately from other quarters to make sure that our results are not driven by the IPOs that took place during this period. Moreover, in our multivariate regressions we use a dummy variable *Bubble* that is equal to 1 if an IPO took place during the bubble period to control for the impact of Nasdaq Bubble.[10]

The statistics on initial returns show that, on average, firms that go public in hot markets are not underpriced more than those that conduct IPOs in warm markets. In fact, excluding the extremely underpriced IPOs of the Bubble Period, hot IPOs are underpriced less than warm IPOs on average. However, as Figure 3a reveals, the average underpricing figure for hot markets masks the variation in underpricing during the course of hot markets. When leaders and followers examined separately, we find that leaders are underpriced twice more on average (32.06 versus 14.67 percentage points).

The mean and median values of market to book ratios are 3 and 2 times higher respectively for leaders compared to followers. That is, investors seem to believe that leaders have more valuable growth opportunities at the time of their IPOs than followers. The median leader is 1 year younger than the median follower, it is less profitable, and it has less long-term debt. Thus, compared to the median follower, the median leader looks more like a young growth firm that is not profitable enough to obtain debt financing. Furthermore, venture capital backing is more frequent among leaders, which we interpret as a signal of their growth potential.

Finally, leaders and followers do not differ substantially in terms of the proceeds they raise, their pre-IPO capital expenditures and net sales. Leaders are slightly larger in terms of total assets, and the number of secondary shares they offer as a percentage of total number of shares offered is slightly lower.

4.3 Are leaders firms with better growth opportunities that signal their quality via underpricing?

The main implication of our model is that if the IPO market is in a pooling equilibrium average underpricing in a hot market is zero, but when it is in a signaling equilibrium,

[10] There has been a regime shift in IPO underpricing and the type of firms that went public during this period (see e.g. Ljungqvist and Wilhelm (2003)).

average underpricing is initially high and then falls sharply. This is because, high-quality firms lead hot markets and underprice their issues to signal their superior growth opportunities.

If this is the case, after controlling for factors that are known to explain underpricing, being a leader in a hot market should still have marginal explanatory power on underpricing. Consequently, we regress underpricing $IniR$ of hot market IPOs on our dummy variable for leaders L and a set of control variables. The results are reported in Table 3. The coefficient estimate for L, which is significant at 1%, suggests that, all else equal, becoming a leader in a hot market is associated with 16.43% more underpricing. As a robustness check, we modify our definition of a leader. L classifies IPOs that take place in the quarter that immediately precedes a hot market ($Q = 0$) and those that take place in the first quarter of a hot market ($Q = 1$) as leaders. The modified variable L_a is more strict and only considers firms that go public in $Q = 1$ as leaders. The coefficient estimate for L_a is also significant at 1% and its magnitude is even greater. These findings support our model's implication that high-quality issuers have to underprice their issues more in order to prevent low-quality issuers from imitating them.

High-quality firms would lead hot markets and underprice their issues only if these actions reveal their quality to investors. Then, it must be the case that, following their IPOs, the growth opportunities of leaders are valued more than those of followers by the market. We use a firm's market to book ratio as a proxy for the market's assessment of the firm's value of growth opportunities. We regress the market to book ratios of hot market IPOs in the year they go public $MtoB_0$ on L (or L_a) and the control variables we used in the underpricing regressions. The results in the final two columns of Table 3 indicate that market to book ratios of leaders in their IPO year exceed those of followers by more than 3, keeping other factors fixed. This provides evidence that investors interpret high-quality firms' actions as a credible signal and attribute higher value to their growth opportunities as a consequence.

4.4 Can investors distinguish leaders from followers?

If investors could predict that a firm will be a leader based on the firm's observable characteristics at the time of its IPO, high-quality firms would not need to signal their quality as their distinct characteristics would reveal them.

In order to investigate whether leaders have distinct characteristics, we run logistic regression models. The dependent variable in these regressions is L (see Equation (9)), and independent variables are issue and firm characteristics observable at the time when firms go public. The results are presented in Table 4. Model (1) uses issue characteristics only, (2) uses firm characteristics only, (3) uses both, and (4) also uses both, but excludes bubble period IPOs.

In the previous section, we argued that the median leader firm looks more like a growth firm than the median follower firm (lower profitability and long-term debt, and higher likelihood of venture capital backing), which is consistent with our model's outcome that leaders have better growth opportunities. The results of the logistic regression models concord with this argument. $Prof$ and $Debt$ have negative and $VCap$ has positive coefficient signs. However, the coefficients are very small. Moreover, across four models, the highest (pseudo) R^2 value is only 0.02. This suggests that the explanatory variables are not helpful in distinguishing leaders from followers. Further evidence for this is provided in Panel B, which reports results on classification. For instance, Model (4) can identify only 11 IPOs that have more than 50% probability of being leaders, and only 5 of these of IPOs are actually among the 502 leaders.

Overall, the results indicate that IPO firms that become leaders do not differ from those that become followers in terms of ex-ante observable characteristics to an extent that would enable investors to distinguish them with confidence. They lend support to our third hypothesis $H3$.

4.5 Do leaders grow faster ex-post?

Our model suggest that when the IPO market is in a signaling equilibrium, firms that have better growth opportunities lead hot markets. If this is the case, we would expect such firms to grow faster following their IPOs. In this section, we compare hot market IPOs' values of total assets, net sales, capital expenditures, and EBITDA before they go public in $y = -1$ and after they go public in $y = 1$. We investigate whether, among hot market IPOs, leaders experience higher rates of growth.

Our findings are summarized in Table 5. The growth rates are measured as changes in logarithms. For instance, the growth rate in assets is measured as $\Delta Assets = ln(Assets_1) - ln(Assets_{-1})$. Panel A shows that median growth rates are higher for leaders and the differences in medians are statistically significant. Panel B reports OLS regression results for models in which the growth rates are dependent variables. The main variable of interest is L, which is equal to 1 (0) if the IPO firm is a leader (follower). All else equal, assets, net sales, capital expenditures, and EBITDA of leaders grow 20.60, 19.21, 9.14, and 14.51 percent more respectively. Of these four differential growth rates, assets, net sales, and EBITDA growth are statistically significant at 1%. These findings are consistent with $H4$, which states firms that lead hot markets grow faster ex post.

Note that, according to our model, the IPO market is either in a pooling equilibrium in which firms move together, or in a separating/signaling equilibrium in which high-quality firms move first and low-quality firms follow. In Section 2.2, we discussed that signaling equilibrium is much more likely to be observed empirically compared to a seperating equilibrium. Therefore, of the 7 hot markets we identify in our sample period, we expect some of them to represent our model's pooling equilibrium and others its signaling equilibrium. In Figure 3a, we provided evidence that average underpricing falls sharply during the course of a hot market, which is the main characteristic of signaling equilibria. In Figure 4, we re-examine this evidence by splitting the 7 hot markets into two groups. The first group contains the two hot markets (No. 3 & 7) that we suspect are in signaling equilibria. Hot market No. 3 is between the 4th quarter of 1982 and the 3rd quarter of 1984, and hot market No. 7 is between the 2nd quarter of 1999 and the 2nd quarter of 2000. Figure 4a shows that underpricing falls sharply after $Q = 1$ for these two hot markets, whereas Figure 4b shows that underpricing is low and uniform during the course of remaining five hot markets, which we suspect are in a pooling equilibrium.

Conditional on hot markets No. 3 & 7 being in signaling equilibria and remaining ones being in pooling equilibria, we should observe a differential ex-post performance across leaders and followers only in the first group of hot markets. In this spirit, we compare the ex-post growth of leaders and followers separately for each group of hot markets. Our findings are presented in Table 6. Panel A shows that, consistent with our expectations, the leaders in hot markets No. 3 & 7 experience stronger growth compared to the followers in the same group of hot markets. The leaders in other hot markets do not outgrow followers in that group of hot markets. Panel B reports OLS regression results. We use the same set of explanatory variables used in Table 5 and report coefficient estimates for our main variable of interest L. For the hot markets that we believe are in signaling equilibria, the coefficient estimates are positive significant, and for the remaining ones that are likely to be in pooling equilibria, the coefficients are insignificant at 5% level. Moreover, for the first group of hot markets, the coefficients on L are much larger than the coefficients of the same variable in Panel B of Table 5. Furthermore, when $\Delta CapX$ is the dependent variable, the coefficient estimate of L, which was insignificant when we ran regressions using pooled data from all 7 hot markets, becomes significant.

Overall, we find evidence of superior growth by leaders in hot markets that are likely to be in signaling equilibria. Leaders in hot markets that are likely to be in pooling equilibria do not grow faster ex post.

4.6 The relationship between IPO volume and average underpricing

Lowry and Schwert (2002) document a lead-lag relationship between aggregate IPO volume and average IPO underpricing. They find that higher average underpricing leads to higher aggregate volume and that this causal relationship is significant. It is rather puzzling that more firms go public as average underpricing increases, since underpricing is an indirect issuing cost for IPO firms. They claim that this relationship is due to releases of positive information, which are not fully incorporated into offer prices (see Loughran and Ritter (2002)). The partial incorporation causes high average underpricing, and the positive information leads to high future IPO volume.

Our model's outcome implies that the positive relationship between current average underpricing and future IPO volume documented by Lowry and Schwert (2002) is spurious. It should be the improvements in market conditions that lead to periods of high average underpricing and high IPO volume. In order to investigate the causal relationships between market returns, average underpricing and IPO volume, we run third-order vector autoregressions (VAR), similar to those in Lowry and Schwert (2002), using monthly data on average underpricing and IPO volume. Dummy variables for the months of January and September are included as exogenous variables to control for seasonality effects.[11] The results are presented in Table 7. Granger F-tests for Models (1) and (2) show that there is a significant relationship between current average underpricing and future IPO volume, but no significant relationship between current IPO volume and future average underpricing. These results are identical to those reported by Lowry and Schwert (2002). However, the inclusion of lagged market returns as an explanatory variable changes the results. The coefficient of lagged market returns variable is positive significant both in Model (3) and in Model (4). Moreover, Granger F-test for Model (4) shows that the relationship between current average underpricing and future IPO volume loses its significance after controlling for changes in market

[11] Helwege and Liang (2004) note that fewer IPOs take place during January and September in the US, due to the difficulties in scheduling road shows during vacation times.

conditions. These findings lend support to the hypotheses $H5$ and $H6$, which argue that improving market conditions cause an increase in both average underpricing and aggregate volume, and the relationship between current underpricing and future volume stems from changes in market conditions.

5 Conclusion

The purpose of this paper is to study the IPO timing decision of firms. In particular, we are interested in understanding why some firms lead an IPO wave, whereas others initially wait and go public later on in the same wave. Our model of IPO timing is based on two main assumptions: (1) the value of a firm's growth opportunities is uncertain and depends on the state of the economy; (2) some firms have better growth opportunities than others and investors cannot recognize those firms. The first assumption gives *all* firms an incentive to wait, whereas the second one gives *high-quality* firms an incentive to move. This creates a tradeoff, such that high-quality firms compare the value of their real option to go public with the value of revealing their type to investors.

Our model's outcome suggests that when the economy is likely to be bad, all firms wait, since the real option to go public is very valuable in this case. However, when there is sufficient probability of a good economy, high-quality firms move in order to signal their type to investors. Furthermore, they underprice their shares in order to prevent low-quality firms from mimicking their action. Even though they accept an unfair valuation, this is still a better valuation than the one they would have got had they waited to go public alongside low-quality firms.

These results provide us a theoretical framework of hot markets. According to our model, hot markets are likely to be either in a pooling or in a signaling equilibrium. In the former type of equilibrium, the average IPO quality is constant and average underpricing is low throughout the hot market. In the latter type of equilibrium, the average IPO quality and underpricing are both initially high and go down later in the hot market. The IPO market is likely to be in a signaling equilibrium when the economic uncertainty is high, the number of high-quality firms is low compared to the number of low-quality firms, and the quality gap between the two types of firms is wide.

Our empirical findings show that within our sample period, some of the hot markets seem to be in signaling equilibria and the remaining ones in pooling equilibria. Average underpricing is much higher at the start of hot markets that seem to be in signaling equilibria. Moreover, the leaders in these hot markets grow faster ex post. It seems that this growth is due to their superior growth opportunities, since investors attribute higher market to book ratios to leaders following their IPOs.

Overall, our theoretical and empirical findings suggest that future research on hot IPO markets should take into account the IPO timing strategies of firms within hot markets. Average firm quality and underpricing need not be constant throughout a hot market. We show that average underpricing is much higher initially in some hot markets, and the leaders in such hot markets seem to have better growth opportunities.

A Proofs of Propositions

We start with the proof of pooling equilibrium presented in Proposition 1. It is intuitive that when q is small, all firms prefer to wait, since their growth opportunities are unlikely to payoff at $t = 1$. If the economy, despite the low probability, turns out to be good at $t = 1$, firms go public. In such a case, investors' breakeven condition at $t = 1$ is:

$$(1 - \alpha_p)(pV_g + (1 - p)V_b) = I$$

Solving for α_p yields Equation (2). Pooling is an equilibrium if no firm is willing to deviate by going public at $t = 0$. This depends on what investors would believe about the type of a firm that follows this out-of-equilibrium strategy. For instance, if they would believe that such a firm is of low-quality, pooling is, clearly, always an equilibrium. However, such a belief is against the Cho-Kreps intuitive criterion (see Cho and Kreps (1987)), since low-quality firms are precisely the type of firms that would not follow the out-of-equilibrium strategy. Therefore, consistent with this criterion, we assume that investors believe high-quality firms would follow the out-of-equilibrium strategy, since they have a very strong incentive to do so. Then, if an IPO were to take place at $t = 0$, investors would believe their breakeven condition is:

$$(1 - \alpha_g)qV_g = I$$

Solving for α_g yields Equation (4). Then, high-quality firms can either pool with low-quality ones if the economy is good at $t = 1$ and retain an equity stake of fraction α_p, or they can take the risk of going public at $t = 0$ and retain an equity stake of fraction α_g. They prefer to pool as long as:

$$\alpha_g qV_g - c \leq q(\alpha_p V_g - c)$$

This inequality is satisfied when q is less than or equal to $\underline{q}$ (see Equation (1)). Therefore, the IPO market is in a pooling equilibrium when $q \leq \underline{q}$, and high-quality firms deviate when $q > \underline{q}$.

Next, we prove Proposition 2, which describes a separating equilibrium in which high-quality firms go public at $t = 0$, and low-quality ones go public at $t = 1$ if the economy is good. In equilibrium, investors' beliefs should be consistent with the actions of firms, such that they should value any firm that goes public at $t = 0$ ($t = 1$) as a high-quality (low-quality) firm. Consequently, at $t = 0$, firms can retain fraction α_g of their equity, which is the maximum fraction that satisfies investors' breakeven condition when investors believe they are faced with high-quality firms. Similarly, investors believe they are faced with low-quality firms at $t = 1$. Thus, their breakeven condition at that time is:

$$(1 - \alpha_b)V_b = I$$

Solving for α_b yields Equation (5). Separating is an equilibrium if it is optimal for high-quality firms to move and for low-quality ones to wait. Low-quality firms can have an incentive to deviate, since if they move they would be valued as high-quality firms by investors. Therefore, separating equilibrium is maintained as long as low-quality firms' optimal action is to wait:

$$\alpha_g q V_b - c \leq q(\alpha_b V_b - c)$$

This inequality is satisfied when q is less than or equal to q^* (see Equation (3)). Therefore, the IPO market is in a separating equilibrium when $\underline{q} < q \leq q^*$, and low-quality firms deviate when $q > q^*$.

We now provide a proof of Proposition 3, which deals with the signaling equilibrium. We showed above that the separating equilibrium breaks down when $q > q^*$, since low-quality firms move in order to mimic high-quality firms. High-quality firms can prevent this by agreeing to retain an equity stake of α_u that is smaller than α_g, such that low-quality firms become indifferent between moving and waiting:

$$\alpha_u q V_b - c = q(\alpha_b V_b - c)$$

Solving for α_u yields Equation (7). Signaling is an equilibrium as long as it is optimal for high-quality firms to underprice their issues. These firms have to underprice more when q is high (i.e. $\partial\alpha_u/\partial q < 0$). Consequently, when q reaches a threshold, they are no longer better off by signaling their quality, and when q exceeds that threshold they would rather pool with low-quality firms. This threshold is determined by the following inequality:

$$\alpha_u q V_g - c \leq q(\alpha_p V_g - c)$$

which is satisfied when q is less than or equal to $\overline{q}$ (see Equation (6)). Thus, the IPO market is in a signaling equilibrium when $q^* < q \leq \overline{q}$, and high-quality firms deviate when $q > \overline{q}$.

Finally, we prove Proposition 4. We argued that when $q > \overline{q}$, high-quality firms are better off by pooling with low-quality firms at $t = 1$. As in Proposition 1, whether pooling is an equilibrium or not depends on investors' belief about the type of firms that go public at $t = 0$. Clearly, high-quality firms have an incentive to follow this strategy, if investors would believe that an IPO at $t = 0$ is conducted by a high-quality firm. But, under such a belief, given that q is high, low-quality firms would also have an incentive to follow the same strategy to benefit from being valued as high-quality firms. Therefore, we assume that, when $q > \overline{q}$, if investors were to observe a firm going public at $t = 0$, they would believe the firm is of high-quality with probability p. Consequently, their breakeven condition would be:

$$(1 - \alpha_{p0})(pqV_g + (1 - p)qV_b) = I$$

It is easy to show that α_{p0} is always less than or equal to α_p, since $q \leq 1$. Therefore, both types of firms are better off by pooling at $t = 1$, since the fraction of equity they would retain if they go public at $t = 0$ is smaller, let alone the uncertainty of going public at $t = 0$. As a result, the IPO market is in a pooling equilibrium when $\overline{q} < q \leq 1$, such that all firms wait at $t = 0$ and go public at $t = 1$ if the economy is good.

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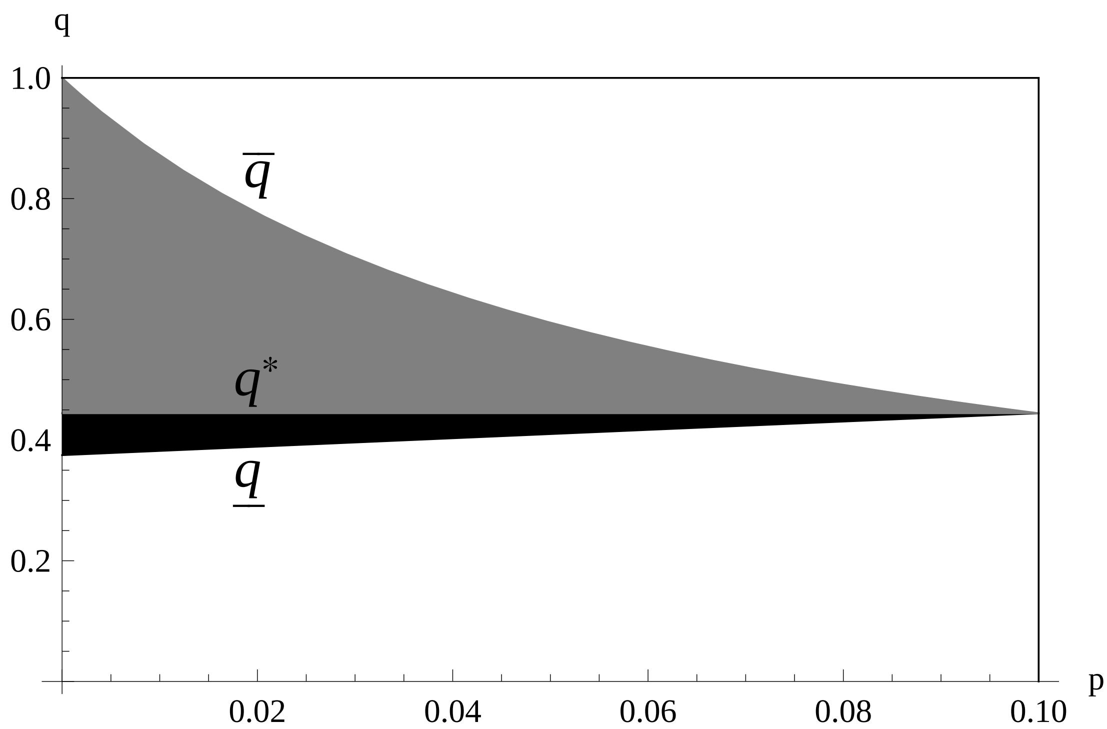


Figure 1: The model's outcome.

The IPO market is in a pooling equilibrium in the two white regions, in a separating equilibrium in the black region, and in a signalling equilibrium in the gray region. The black region is bounded by $\underline{q}$ and q^*. The gray region is bounded by q^* and $\overline{q}$. p is the probability that a firm is of high-quality, q is the probability that the economy is good at $t = 1$. The parameter values used for this figure are $\{V_g, V_b, I, c\} = \{360, 120, 100, 20\}$.

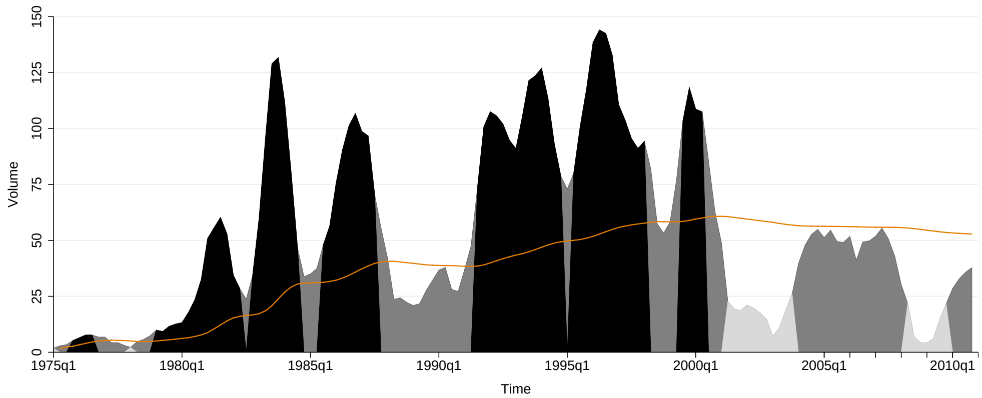


Figure 2: Hot markets between 1975 and 2010.

The area plot is the 4-quarter moving average IPO volume $ma(4)$. Black, dark gray, and light gray areas represent hot, warm, and cold quarters respectively. A quarter is classified as hot (cold) if its $ma(4)$ exceeds (falls short of) the historical average in previous quarters by 50%. A quarter is classified as warm if it is neither hot or cold. The line plot represents the historical average. Quarterly IPO volume is deflated by the number of public firms in the previous quarter before $ma(4)$ is calculated. Public firms are identified as those that have a sharecode of 10 or 11 in CRSP.

Table 1: A numerical example of signaling equilibrium

The top pair in parantheses is the range of underpricing over the range of q, where $q \in (q^*, \overline{q})$. The bottom pair in parantheses is $(q^*, \overline{q})$. The IPO market is in a signaling equilibrium when q lies in this range. Underpricing is defined in Equation (8). q^* and $\overline{q}$ are defined in Equations (3) and (6) respectively. p is the probability that a firm is of high-quality. V_g and V_b are the payoffs of growth opportunities for high- and low-quality firms if the economy is good at $t = 1$. I and c are the investment and issuing costs respectively. For some calibrations q^* exceeds $\overline{q}$ in which case the IPO market is never in a signaling equilibrium. The ranges of underpricing and q are not reported in those cases.

	Panel A: p=2.5%		
	c/I=20%	c/I=15%	c/I=10%
V_g/V_b=3	(0.00% , 105.26%) (0.44 , 0.74)	(0.00% , 88.71%) (0.42 , 0.68)	(0.00% , 62.50%) (0.39 , 0.58)
V_g/V_b=2.5	(0.00% , 80.56%) (0.50 , 0.77)	(0.00% , 67.62%) (0.48 , 0.71)	(0.00% , 46.62%) (0.45 , 0.62)
V_g/V_b=2	(0.00% , 52.94%) (0.58 , 0.80)	(0.00% , 43.56%) (0.57 , 0.75)	(0.00% , 27.87%) (0.55 , 0.67)
	Panel B: p=5.0%		
	c/I=20%	c/I=15%	c/I=10%
V_g/V_b=3	(0.00% , 54.05%) (0.44 , 0.59)	(0.00% , 35.71%) (0.42 , 0.52)	(0.00% , 9.62%) (0.39 , 0.42)
V_g/V_b=2.5	(0.00% , 39.71%) (0.50 , 0.63)	(0.00% , 24.45%) (0.48 , 0.56)	(0.00% , 2.15%) (0.45 , 0.46)
V_g/V_b=2	(0.00% , 22.58%) (0.58 , 0.68)	(0.00% , 10.68%) (0.57 , 0.61)	
	Panel C: p=7.5%		
	c/I=20%	c/I=15%	c/I=10%
V_g/V_b=3	(0.00% , 21.98%) (0.44 , 0.51)	(0.00% , 4.72%) (0.42 , 0.43)	
V_g/V_b=2.5	(0.00% , 12.80%) (0.50 , 0.54)		
V_g/V_b=2	(0.00% , 1.37%) (0.58 , 0.59)		

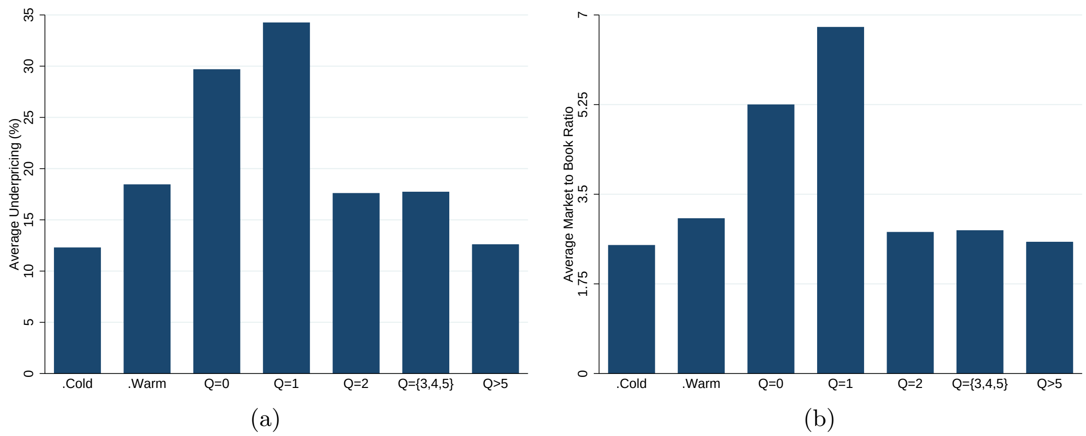


Figure 3: Average underpricing and market to book ratio during the course of hot markets.

In panel (3a) the bar $Q = i$ represents the level of average underpricing $IniR$, and in panel (3b) it represents the level of average market to book ratio $MtoB_0$ of firms that went public in the ith quarter of a hot market. The averages in cold and warm quarters are also provided in each panel. A quarter is classified as hot (cold) if its $ma(4)$ exceeds (falls short of) the historical average in previous quarters by 50%. A quarter is classified as warm if it is neither hot nor cold. Quarterly IPO volume is deflated by the number of public firms in the previous quarter before $ma(4)$ is calculated. Public firms are identified as those that have a sharecode of 10 or 11 in CRSP.

Table 2: Descriptive Statistics

$IniR$ is the initial percentage return between the offer price and the first trading day closing price. $MtoB_0$ is the market to book ratio in $y = 0$. $TPro$ is the total proceeds as a percentage of total assets in $y = 0$. Age is the difference between the firm's IPO and foundation years. $SecS$ is the number of secondary shares offered as a percentage of total shares offered. $VCap$ is a dummy variable equal to 1 if the IPO is backed by a venture capital firm. $Sales_{-1}$ and $Assets_{-1}$ are net sales and total assets measured in millions of 2010 dollars in $y = -1$ respectively. $CapX_{-1}$ is capital expenditures, $Prof_{-1}$ is EBITDA, $Debt_{-1}$ is long-term debt in $y = -1$, all expressed as a percentage of total assets in $y = -1$.

Panel A: Issue Characteristics

		$IniR$		$MtoB_0$		$TPro$		Age		$SecS$		$VCap$	
	count	mean	median	mean	median	mean	median	mean	median	mean	median	mean	median
Cold	172	12.28	8.88	2.50	1.92	63.12	51.37	21.88	11.00	16.31	0.00	0.45	0.00
Warm	1,487	20.46	7.81	3.42	2.18	57.77	51.89	14.60	7.00	11.76	0.00	0.47	0.00
Hot (w B.)	3,843	20.88	7.69	3.19	2.16	62.06	57.04	12.68	7.00	12.30	0.00	0.43	0.00
Hot (w/o B.)	3,635	16.25	7.00	2.98	2.13	61.57	55.90	12.95	7.00	12.86	0.00	0.41	0.00
Bubble	208	100.36	64.85	6.78	3.61	70.70	70.72	8.19	5.00	2.35	0.00	0.73	1.00
Leaders	552	32.06	12.50	6.04	2.99	61.38	56.09	12.08	6.00	11.97	0.00	0.50	0.50
Followers	3,553	14.67	6.52	2.65	2.08	61.58	55.81	13.11	7.00	13.04	0.00	0.40	0.00
All	5,502	20.49	7.81	3.23	2.16	60.94	55.29	13.49	7.00	12.28	0.00	0.44	0.00

Panel B: Firm Characteristics

		$Sales_{-1}$		$Assets_{-1}$		$CapX_{-1}$		$Prof_{-1}$		$Debt_{-1}$	
	count	mean	median	mean	median	mean	median	mean	median	mean	median
Cold	167	572.78	162.00	488.73	130.11	7.03	4.39	-1.98	10.56	28.02	20.73
Warm	1,345	251.36	42.46	289.65	41.36	9.57	5.81	-15.24	9.35	25.17	10.47
Hot (w B.)	3,437	170.33	32.41	145.22	24.49	10.96	6.77	-4.18	14.14	24.57	11.88
Hot (w/o B.)	3,239	167.37	33.69	140.83	24.51	10.92	6.74	-0.63	15.06	24.88	12.64
Bubble	198	218.74	11.62	217.07	23.73	11.65	7.71	-62.30	-37.23	19.44	4.21
Leaders	505	181.69	29.01	173.89	26.78	10.32	7.67	-21.39	11.75	22.87	8.44
Followers	2,974	170.00	34.18	143.95	24.49	10.96	6.55	0.82	15.42	25.18	13.13
All	4,949	205.93	35.98	196.07	29.45	10.45	6.45	-7.11	12.81	24.85	11.71

Table 3: Are leaders firms with better growth opportunities that signal their quality via underpricing?

The column headings indicate the dependent variable of each model, and the variables in rows are the independent variables. $IniR$ is the initial percentage return between the offer price and the first trading day closing price. $MtoB_0$ is the market to book ratio in $y = 0$. L is the dummy for leaders, which is equal to 1 if $0 \leq Q \leq 1$ and to 0 if $Q > 1$, where $Q = q$ means that a firm goes public during the qth quarter of a hot market. L_a is an alternative dummy for leaders, which is equal to 1 if $Q = 1$ and to 0 if $Q > 1$. Age is the difference between the firm's IPO and foundation years. $VCap$ is a dummy variable equal to 1 if the IPO is backed by a venture capital firm. $PSec$ is the number of secondary shares offered as a percentage of total shares offered. $TPro$ is the total proceeds as a percentage of total assets in $y = 0$. $Sales_{-1}$ is net sales measured in millions of 2010 dollars in $y = -1$. $CapX_{-1}$ is capital expenditures, $Prof_{-1}$ is EBITDA, $Debt_{-1}$ is long-term debt in $y = -1$, all expressed as a percentage of total assets in $y = -1$. $Bubble$ is a dummy variable, which is equal to 1 if the IPO took place during the bubble period (4th quarter of 1999 or 1st quarter of 2000). All models include 3-digit SIC dummies. Robust t-statistics are in parentheses. ***, **, and * stand for significance at 1, 5, and 10 percent levels respectively.

	$IniR$	$IniR$	$MtoB$	$MtoB$
L	16.43***		3.13***	
	(4.55)		(3.00)	
L_a		18.21***		3.79***
		(4.25)		(3.02)
Age	-0.14***	-0.13***	-0.01**	-0.01***
	(-3.77)	(-3.32)	(-2.44)	(-2.68)
$VCap$	7.05***	6.06**	0.64**	0.50**
	(2.82)	(2.16)	(2.12)	(2.03)
$PSec$	-0.16***	-0.14***	-0.01	-0.00
	(-3.16)	(-3.27)	(-1.20)	(-0.96)
$TPro$	-0.00	0.00	-0.00	-0.00
	(-0.02)	(0.06)	(-1.04)	(-0.64)
$ln(Sales_{-1})$	0.19	0.29	-0.17***	-0.13***
	(0.55)	(0.81)	(-2.87)	(-2.91)
$CapX_{-1}$	0.03	0.04	0.00	0.00
	(0.73)	(1.00)	(0.17)	(0.33)
$Prof_{-1}$	-0.02**	-0.01	-0.00**	-0.01***
	(-2.37)	(-0.83)	(-2.15)	(-5.06)
$Debt_{-1}$	-0.05***	-0.04**	-0.00**	-0.00***
	(-3.30)	(-2.46)	(-2.06)	(-2.82)
$Bubble$	76.80***	78.91***	2.00***	2.13***
	(8.64)	(8.91)	(3.38)	(3.65)
Con.	16.22***	15.39***	3.36***	3.23***
	(10.45)	(8.63)	(20.76)	(26.98)
Obs.	3,568	3,329	3,574	3,337
R-sq.	0.19	0.21	0.10	0.11

Table 4: Can investors distinguish leaders from followers?

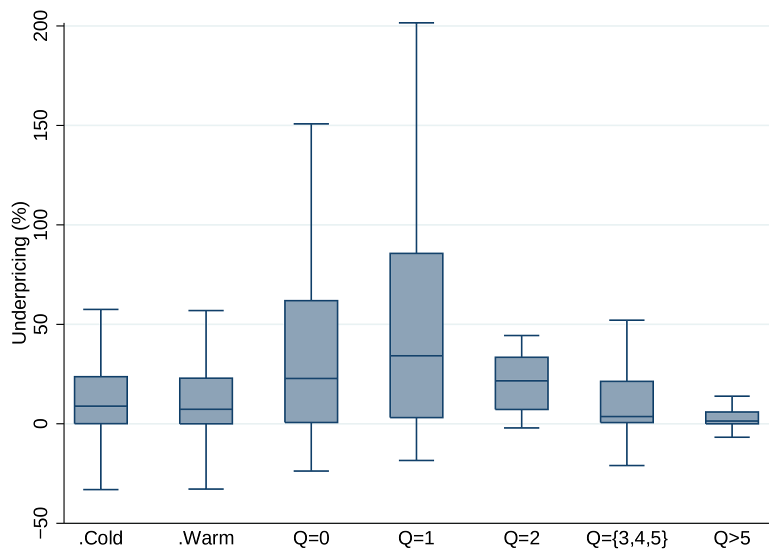
In all logistic regression models, the dependent variable is L, which is equal to 1 if $0 \leq Q \leq 1$ and to 0 if $Q \geq 1$, where $Q = q$ means that a firm goes public during the qth quarter of a hot market. Model (4) excludes IPOs that took place during the 4th quarter of 1999 and the 1st quarter of 2000 (bubble period quarters). Age is the difference between the firm's IPO and foundation years. $VCap$ is a dummy variable equal to 1 if the IPO is backed by a venture capital firm. $PSec$ is the number of secondary shares offered as a percentage of total shares offered. $TPro$ is the total proceeds as a percentage of total assets in $y = 0$. $Sales_{-1}$ is net sales measured in millions of 2010 dollars in $y = -1$. $CapX_{-1}$ is capital expenditures, $Prof_{-1}$ is EBITDA, $Debt_{-1}$ is long-term debt in $y = -1$ as a percentage of total assets in $y = -1$. Robust t-statistics are in parentheses. ***, **, and * stand for significance at 1, 5, and 10 percent levels respectively. In Panel B, $L = 1$ is the number of leaders in each model. $p \geq 0.50$ ($p \geq 0.25$) gives the number of firms that are predicted to become leaders with at least 50% (25%) probability and the number of firms that actually are leaders among the predicted ones. The figure after the slash is the number predicted and the figure before the slash is the actual number.

Model	(1)	(2)	(3)	(4)
		Panel A: Regressors		
Age	-0.00		-0.00	-0.00
	(-0.31)		(-1.01)	(-1.12)
$VCap$	0.29***		0.24**	0.29***
	(3.08)		(2.33)	(2.85)
$PSec$	-0.00		-0.00	-0.00
	(-0.56)		(-0.65)	(-1.24)
$TPro$	-0.00		0.00	0.00
	(-0.54)		(0.28)	(1.09)
$ln(Sales_{-1})$		0.05**	0.07**	0.09***
		(2.02)	(2.56)	(3.19)
$CapX_{-1}$		-0.01	-0.01	-0.00
		(-1.52)	(-1.43)	(-1.17)
$Prof_{-1}$		-0.00***	-0.00***	-0.00***
		(-4.77)	(-4.46)	(-5.73)
$Debt_{-1}$		-0.00*	-0.00	-0.00**
		(-1.80)	(-1.57)	(-2.28)
Con.	-1.91***	-1.91***	-2.02***	-2.02***
	(-16.49)	(-17.63)	(-15.33)	(-14.94)
Obs.	3,968	3,677	3,595	3,399
R-sq.	0.00	0.00	0.01	0.02
		Panel B: Classification		
L=1	544	505	502	502
$p \geq 0.50$	0/0	1/4	1/3	5/11
$p \geq 0.25$	0/0	7/31	8/36	28/83

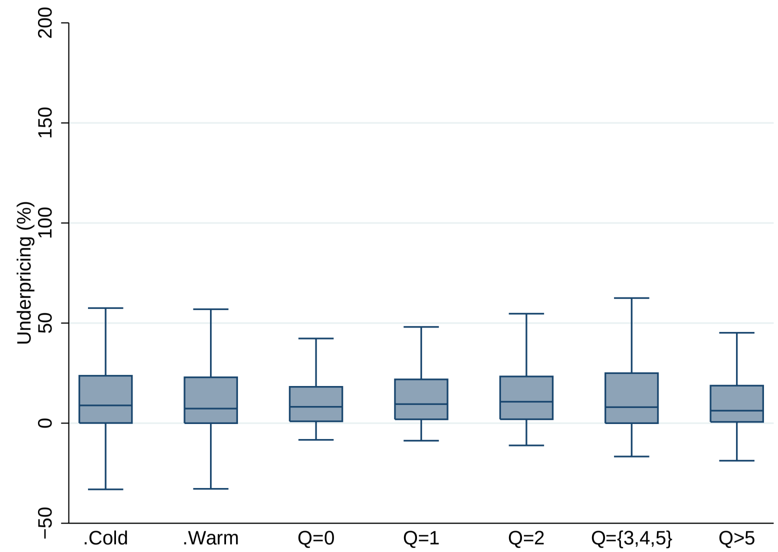
Table 5: Do leaders grow faster ex post?

$\Delta Assets = ln(Assets_1) - ln(Assets_{-1})$. $\Delta Sales$, $\Delta CapX$, and $\Delta Prof$ are calculated the same way. Panel A reports the median values and the p-values of a median test between leaders and followers. Panel B reports OLS regression results for models in which growth rates are regressed on a set of explanatory variables. L classifies IPOs as leaders or followers, such that $L = 1$ if $0 \leq Q \leq 1$ and to 0 if $Q \geq 1$, where $Q = q$ means that a firm goes public during the qth quarter of a hot market. $Sales_{-1}$ is net sales measured in millions of 2010 dollars in $y = -1$. $CapX_{-1}$ is capital expenditures, $Prof_{-1}$ is EBITDA, $Debt_{-1}$ is long-term debt in $y = -1$, all expressed as a percentage of total assets in $y = -1$. Age is the difference between the firm's IPO and foundation years. $VCap$ is a dummy variable equal to 1 if the IPO is backed by a venture capital firm. $PSec$ is the number of secondary shares offered as a percentage of total shares offered. $TPro$ is the total proceeds as a percentage of total assets in $y = 0$. $Bubble$ is a dummy variable, which is equal to 1 if the IPO took place during the bubble period (4th quarter of 1999 or 1st quarter of 2000). All models include 3-digit SIC dummies. Robust t-statistics are in parentheses. ***, **, and * stand for significance at 1, 5, and 10 percent levels respectively.

	$\Delta Assets$	$\Delta Sales$	$\Delta CapX$	$\Delta Prof$
Panel A: Median growth rates				
Cold/Warm	93	58.03	79.42	66.68
Followers	105.64	63.39	108.75	66.81
Leaders	118.25	76.74	122.54	79.02
p-values	0.04	0.00	0.04	0.03
Panel B: Regression analysis				
L	20.60***	19.21***	9.14	14.51***
	(3.26)	(3.31)	(1.37)	(2.91)
$ln(Sales_{-1})$	-12.57***	-22.45***	-14.06***	-6.89***
	(-6.72)	(-12.76)	(-6.61)	(-4.40)
$CapX_{-1}$	0.40**	0.56***	-3.52***	0.15
	(2.14)	(3.12)	(-10.46)	(0.93)
$Prof_{-1}$	-0.10*	-0.16**	0.08	0.07**
	(-1.71)	(-2.57)	(1.03)	(2.35)
$Debt_{-1}$	-0.07	-0.10**	0.07	-0.13**
	(-1.06)	(-2.04)	(0.88)	(-2.13)
Age	-0.51***	-0.10	-0.63***	-0.28**
	(-5.00)	(-1.25)	(-4.48)	(-2.25)
$VCap$	5.12*	23.23***	1.49	14.82***
	(1.78)	(7.24)	(0.33)	(2.77)
$PSec$	-0.27***	-0.21**	-0.42***	-0.40***
	(-3.50)	(-2.08)	(-4.54)	(-4.11)
$TPro$	0.01***	0.00**	0.02***	0.01***
	(3.93)	(2.28)	(3.07)	(2.99)
$Bubble$	26.73***	35.97***	-15.39	7.21
	(4.15)	(2.74)	(-1.55)	(0.94)
Con.	164.26***	151.36***	210.75***	101.72***
	(26.07)	(27.57)	(26.99)	(17.22)
Obs.	3,380	3,271	3,316	2,820
R-sq.	0.27	0.29	0.20	0.07



(a) Hot markets No. 3 & 7



(b) Remaining hot markets

Figure 4: Signaling versus pooling equilibrium in hot markets.

The box plots show the distribution of underpricing in cold quarters, warm quarters, and in each quarter of a hot market. In Panel (a), hot market No. 3 is between the 4th quarter of 1982 and the 3rd quarter of 1984, and hot market No. 7 is between the 2nd quarter of 1999 and the 2nd quarter of 2000. A quarter is classified as hot (cold) if its $ma(4)$ exceeds (falls short of) the historical average in previous quarters by 50%. A quarter is classified as warm if it is neither hot nor cold. Quarterly IPO volume is deflated by the number of public firms in the previous quarter before $ma(4)$ is calculated. Public firms are identified as those that have a sharecode of 10 or 11 in CRSP.

Table 6: A comparison of ex-post growth between leaders and follower across hot markets that are in signaling equilibria and those that are in pooling equilibria

7 hot markets are split into two groups. The first group contains hot markets No. 3 & 7, which we believe are in signaling equilibria, and the second group contains the remaining hot markets that we believe are in pooling equilibria. $\Delta Assets$ is the growth rate of total assets and is calculated as $ln(Assets_1) - ln(Assets_{-1})$. $\Delta Sales$, $\Delta CapX$, and $\Delta Prof$ are the growth rates of net sales, capital expenditures, and EBITDA. They are calculated the same way. Panel A reports the median values and the p-values of a median test between leaders and followers. Panel B reports OLS regression results for models in which growth rates are regressed on a set of explanatory variables, which is identical to the one reported in Table 5. L classifies IPOs as leaders or followers, such that $L = 1$ if $0 \leq Q \leq 1$ and to 0 if $Q \geq 1$, where $Q = q$ means that a firm goes public during the qth quarter of a hot market. All models include 3-digit SIC dummies. Robust t-statistics are in parentheses. ***, **, and * stand for significance at 1, 5, and 10 percent levels respectively.

	$\Delta Assets$	$\Delta Sales$	$\Delta CapX$	$\Delta Prof$
		Panel A: Median growth rates		
No. 3 & 7				
Followers	121.34	81.16	106.68	73.95
Leaders	183.53	156.56	173.76	120.92
p-values	0.00	0.00	0.00	0.00
Others				
Followers	102.69	60.93	109.71	66.28
Leaders	97.35	58.31	91.52	59.22
p-values	0.15	0.80	0.07	0.18
		Panel B: Regression analysis		
No. 3 & 7				
L	72.14***	53.76***	60.99***	65.52***
	(5.00)	(5.73)	(3.54)	(5.72)
Obs.	709	692	697	578
R-sq.	0.35	0.48	0.23	0.19
Others				
L	-1.21	-0.98	-14.37*	-2.91
	(-0.18)	(-0.21)	(-1.71)	(-0.38)
Obs.	2,671	2,579	2,619	2,242
R-sq.	0.23	0.19	0.23	0.07

Table 7: The relationship between IPO volume and average underpricing

The table displays results of the third-order vector autoregressions for monthly average underpricing $IniR_m$ and monthly IPO volume Vol_m. The data is obtained from Jay Ritter's website. For the IPO volume, "net count" variable is used. This variable does not count penny stocks, units, closed-end funds, REITs acquisition companies, ADRs, limited partnerships, banks and S&Ls, and IPO firms that are not listed on CRSP. The data on this variable is available from 1975 till 2010. Jan and Sep are dummy variables that are equal to 1 if the month is January and September respectively. $R1$ is the return on the monthly average level of the value-weighted index of all NYSE, AMEX, and NASDAQ stocks. Lt represents lag t of a variable, where $t \in \{1, 2, 3\}$. The figures in parentheses are t-statistics and p-values in Panels A and B respectively. ***, **, and * stand for significance at 1, 5, and 10 percent levels respectively.

Model	(1)	(2)	(3)	(4)
Regressand	$IniR_m$	Vol_m	$IniR_m$	Vol_m
		Panel A: Regressors		
$L1.IniR_m$	0.52***	0.07**	0.49***	0.04
	(10.34)	(2.42)	(9.47)	(1.29)
$L2.IniR_m$	0.19***	-0.01	0.20***	-0.00
	(3.44)	(-0.37)	(3.64)	(-0.03)
$L3.IniR_m$	0.02	0.01	0.04	0.02
	(0.48)	(0.24)	(0.74)	(0.73)
$L1.Vol_m$	-0.04	0.59***	-0.08	0.55***
	(-0.52)	(13.19)	(-1.05)	(12.15)
$L2.Vol_m$	0.01	0.01	0.03	0.02
	(0.16)	(0.14)	(0.30)	(0.40)
$L3.Vol_m$	0.01	0.28***	0.04	0.32***
	(0.19)	(6.35)	(0.58)	(7.15)
Jan	5.50**	-12.86***	5.05*	-13.36***
	(2.03)	(-7.91)	(1.87)	(-8.39)
Sep	6.52**	-7.44***	6.50**	-7.46***
	(2.35)	(-4.47)	(2.36)	(-4.60)
$L1.R1$			0.53**	0.58***
			(2.33)	(4.32)
Con.	3.96***	2.63***	3.54**	2.17***
	(2.85)	(3.16)	(2.54)	(2.65)
Obs.	390	390	390	390
R-sq.	0.46	0.74	0.46	0.75
		Panel B: Granger F-tests		
Lagged Vol	0.30		1.24	
	(0.96)		(0.74)	
Lagged IniR		9.38		5.73
		(0.03)		(0.13)