Relationship Markets and the Decision to Go Public

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The equity markets for smaller issues are characterized by close economic relationships between new issuers and the underwriters who bring the stock public. Underwriters sponsor new issues and often provide liquidity in the secondary market by acting as market makers. This paper analyzes theoretically the operation of so-called "relationship markets" and their role in facilitating capital formation. The model is consistent with stylized facts concerning both primary and secondary markets and yields several testable predictions. In particular, we show that smaller companies can lower their cost of capital by using relationship markets. However, for sufficiently large issues, a secondary market structure without a dominant primary market maker is preferred. We test the model using data on IPOs from 1996-2000 identifying post-IPO market making activity, using a choice model to control for endogeneity. The results support the conclusion that underpricing is related to anticipated secondary market activity by underwriters.

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1 Introduction

Close economic ties between corporations and their sources of financing characterize many financial markets. Such arrangements, termed "relationship markets," are common in countries where corporations rely primarily on bank financing.[1] Similarly, equity markets for smaller capitalization stocks are characterized by close relationships between new issuers and the underwriters who bring the stock public. In particular, underwriters sponsor new issues by arranging analyst coverage, promoting the stock through marketing efforts, and providing liquidity by acting as broker-dealers in subsequent secondary market trading. Underwriters of smaller stocks often dominate trading in the post-IPO market, giving them considerable ability to affect security prices. Relationship markets are controversial because of the potential conflicts of interest that might arise among interested parties. Yet, despite their prevalence, many academic questions concerning relationship markets remain unanswered. Specifically, why do relationship markets exist in the first place? Do these arrangements affect the cost of capital? Why are such arrangements uncommon for larger firms? How do the ties between issuer and underwriter affect the choice of trading venue?

This paper examines these issues, focusing on the role of underwriters in linking the primary and secondary stock markets for the firms they bring public. We develop a model of a relationship market that closely resembles actual institutional arrangements. In particular, we model the going public decision of a firm whose underwriter is also the primary broker-dealer in secondary market and whose clients are the initial IPO investors. These features of the relationship market are shown to have a crucial effect on the ability of small firms to raise capital in the primary market. We show theoretically that, absent other effects, underpricing exists in equilibrium and is positively related to expected illiquidity in the secondary market. Relationship markets reduce the degree of underpricing for smaller companies, lowering their costs of capital relative to alternative mechanisms involving a separation of underwriting functions in the primary market and market making in the secondary market. By contrast, larger companies may prefer trading in "anonymous" markets where the underwriter and secondary liquidity providers are distinct.

[1] Examples include *Keiretsus* in Japan and *Chaebols* in Korea.

We test the predictions of the model using IPO data from 1996-2000. Our dataset also contains information on underwriter participation in post-IPO trading, providing a proxy for the strength of the relation between the IPO and secondary markets. We use a two-stage technique to capture the influence of market type on the degree of underpricing, while accounting for the endogenous choice of market. The results are broadly supportive of our theoretical conjectures.

In linking primary and secondary markets, our paper is most closely related to Ellul and Pagano (2002). They argue that higher liquidity in the secondary market results in lower underpricing. Using British IPO data, they find a positive relationship between underpricing and the bid-ask spread. We differ from Ellul and Pagano in that we introduce the concept of a relationship market, and explicitly describe conditions under which such an economic mechanism is dominant. Further, from an empirical perspective, our endogenous-choice model is considerably different from their simple regression approach. Our paper also differs from studies, such as Booth and Chua (1996), that explain underpricing as a result of the issuer's demand for a liquid secondary market in that we link the primary and the secondary market through the underwriter.

The model complements other analyses that examine post-IPO trading and liquidity. Aggarwal, Krigman, and Womack (2002) argue that underpricing has a direct benefit in that it causes a shift out in demand for the stock (it induces "positive momentum"), thereby generating underpricing. This explanation is distinct from ours, although the two are by no means mutually exclusive. Kalev, Pham, and Steen (2001) look at the effect of underpricing on aftermarket liquidity (via its effect on ownership structure), whereas our paper is more focused on the effect of aftermarket liquidity and a relationship market on underpricing. Their measure of underpricing is the market-adjusted initial return (first trading day), which they relate to measures of liquidity (trading turnover and bid-ask spread) for 113 IPOs on the Australian Stock Exchange 1996-1999. Their main result is that underpricing affects breadth of ownership and equality of shareholder distribution, and that these affect post-listing liquidity. Our approach suggests that regressions of liquidity on IPO underpricing are problematic because of the endogeneity of IPO underpricing. In many small issues, broker-dealers play an active role in supporting the price (Chowdhry and Nanda, 1996), thereby providing a form of insurance to initial IPO clients. This is similar to, but distinct from, the effects isolated by our model, and requires further analysis. Our study complements studies such as Ber, Yafeh and Yosha (2001) and Schenone (2001) that examine other relationships, such as lending, that underwriters might have with a firm and their effects on underpricing. Similarly, Stoughton and Zechner (1998) note that an investment bank can be viewed as a broker "with an active and continuing relationship with the institutional investment community."

From an empirical perspective also, our results add to the growing body of evidence (see, e.g., Ellis, Michaely, and O'Hara 2000, 2002) on after-market activity. Ellis, Michaely, and O'Hara (2000) examine a sample of Nasdaq IPOs from 1996-1997. They show that the lead underwriter for these IPOs is the most active dealer in the aftermarket and often engages in price support activities. They find that the underwriter benefits from underpricing of the IPO in terms of its aftermarket trading profits, but that underwriting fees dominate aftermarket trading profits as a source of revenue for the underwriter. Using the same dataset, Ellis, Michaely, and O'Hara (2002) show that there tends to be a dominant market maker (the underwriter in the period immediately after the IPO), spreads are increasing in the share of the dominant market maker, and, despite early volatility, the markets tend to stabilize after three months.

Our model's predictions are also broadly consistent with stylized facts concerning both primary and secondary markets. Several studies have documented that among firms qualified to list on both Nasdaq and the NYSE, smaller firms tend to list on Nasdaq (see Corwin, Harris, and Lipson (2002)) despite evidence that issue costs and transaction costs tend to be higher on Nasdaq. We show that smaller firms can get higher offer prices in a relationship market than in a centralized, anonymous market because of the link between primary and secondary market trading. Schultz and Zaman (1994) find that underwriters who make markets in their stocks quote higher bids in subsequent trading, especially in issues that start trading below their offer prices. We argue that such forms of price support are an integral part of a relationship market, and without them, the IPOs could not have been successful without greater underpricing.

We proceed as follows. Section 2 develops a theoretical model of a relationship market that serves as the basis for our subsequent analysis. Section 3 describes our empirical design, while Section 4 outlines our data and sample selection. Section 5 discusses our results, and Section 6 concludes.

2 Model

There are four dates in the model. At date 0, the firm contacts an investment banker who assesses the company's quality and locates investors to purchase its shares. We assume the firm can choose between an underwriter who will act as the lead market maker in the secondary market, i.e., a *relationship market*, and an *anonymous market* where the underwriter does not participate in the secondary market trading. In reality, as we recognize in our empirical tests, the relationship between issuer and underwriter can vary in strength, but for simplicity, all underwriters in relationship markets are assumed to have the same degree of involvement in post-IPO dealing activity.

At dates 1 and 2, the firm's secu rities are traded in a dealer market. Date 1 is a representative trading round during the early high-volatility period, and date 2 is a representative trading round during the later low-volatility period. Our model can be extended easily to allow a large number of trading rounds in the high-volatility period and a large number of trading rounds in the low-volatility period without affecting the qualitative results. Finally, at date 3, the security pays a liquidating dividend.

We are interested in the firm's choice of underwriter, in particular whether the firm chooses an underwriter who will then act as the primary market maker for the stock in the secondary market, and we are interested in how this choice affects the underpricing of the initial offering. We let $R \in \{0,1\}$ denote the firm's choice of anonymous market or relationship market, where a choice of R=1 corresponds to the choice of a relationship market.

Initially, a sole owner-entrepreneur currently holds all S shares in a firm that has access to an indivisible, positive-NPV project that requires a capital investment of K. The riskiness of the firm's project is indexed by $\psi \in [0,\overline{\psi}]$. If undertaken, a project of type ψ pays a liquidating dividend at date 3 given by

$$v \equiv \mu + \sum_{t=1}^{2} \delta_t (1+\psi), \qquad (1)$$

where δ_t represents an innovation to value revealed at the end of date t, and $\mu > 0$ represents the mean asset value. We assume that δ_1 and δ_2 have binomial distributions, where δ_1 equals δ_h and $-\delta_h$ with equal probability, and δ_2 equals δ_λ and $-\delta_\lambda$ with equal probability, where $\delta_h > \delta_\lambda > 0$. Thus, volatility is higher in period 1 than in period 2, and higher ψ firms have a higher variance in their liquidation values. We assume that $\mu - (\delta_\lambda + \delta_h)(1+\overline{\psi}) \geq 0$ to ensure positive expected value for all types of firms at all times. Given this structure, the expected payoff at time 0 if the project is undertaken is μS. If the project is not funded (i.e., if investment is zero) the entrepreneur receives a payoff per share of μ', where $0 \leq \mu' < \mu$.

To fund the project, the entrepreneur must contact an underwriter who then sells shares to the public. We assume competition among investment banks, so that the underwriter acts to maximize the owner's utility. We assume the owner sells *Q blocks* of shares to the public, where $0 < Q \leq S$. Block size is normalized to one unit. At time 0, the investment banker determines the firm's type and reveals this truthfully to clients at the time of the IPO.[2] We assume for the moment that $Q \leq \overline{Q}$, where $\overline{Q}$ is the number of potential investors known to the investment banker to be liquidity motivated, i.e., institutions such as foundations or endowments unlikely to obtain and trade on future private information signals regarding the asset's payoffs. Beyond $\overline{Q}$, the investment banker contacts clients whose reputations are less known, who might include institutions (hedge funds, etc.) that could receive and act on future private information signals.

All potential investors are risk neutral, and we normalize the riskless rate to zero. A client can purchase/trade only one block of shares per period, so Q investors must participate in the IPO for it to be successful. If the firm sells Q shares through the investment bank, the entrepreneur's expected wealth is

$$(S-Q)\mu + p_0(Q \mid \psi, R)Q - K, \tag{2}$$

where $p_0(Q \mid \psi, R)Q$ is the initial offer price as a function of quantity, conditional on firm type, ψ, and whether the market is an anonymous market or a relationship market. If the firm remains private, the entrepreneur's wealth is simply $S\mu'$.

As shown in (2), the entrepreneur's expected wealth does not depend directly on the type of the secondary market; however, it does depend on the initial offer price,

[2] To conserve notation, we assume the cost to the investment bank for this activity is zero, but a fixed cost can be included without affecting our results.

which as we now show, depends on whether the secondary market is an anonymous market or a relationship market.

2.1. Secondary market

At time 1, the security starts trading in a secondary market in which multiple dealers offer to buy or sell the security on demand. We consider two order sizes in the model: large orders (blocks) and small (retail) orders. Without loss of generality, block size is taken to be one unit. The retail order size is size ξ, where $\xi < 1$ is small.

Secondary market trading activity reflects the actions of existing stockholders as well as new traders who buy or sell short the stock. The new traders are: (a) uninformed retail traders, who are equally likely to place small buy or sell orders, (b) institutional liquidity traders, who are equally likely to place large (block) buy or sell orders, and (c) informed traders, who may receive private information about the value innovation to be revealed in the next trading round and trade to maximize expected profits.[3] We refer to these traders as *outside* traders to distinguish them from initial investors (clients). The presence of informed traders implies that the conditional expectation of the value innovation given the net number of block buys in a period, q_t, is increasing in q_t, i.e., for all $k \bullet 0$,

$$E[\delta_t \mid q_t = k+1] > E[\delta_t \mid q_t = k] \text{ and } E[\delta_t \mid q_t = 0] = 0 .$$

Now consider the investors who participate in the initial public offering. For simplicity, we assume that initial investors are not information motivated, but that they may have liquidity motivations for selling their blocks in the secondary market prior to liquidation.[4] To further simplify, we assume liquidity shocks to the initial investors are perfectly correlated. For example, an economy-wide downturn might force institutional investors collectively to reduce their equity holdings. Thus, with probability γ_t all Q of the initial investors face a liquidity shock on date t (and not on date 3-t, t=1,2). We allow

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[3] While informed traders have the option to place small orders, Easley and O'Hara (1987) show that this is not the profit maximizing strategy if the retail order size ξ is sufficiently small. For this reason, we focus on the separating equilibrium in which the informed trader chooses to trade only blocks as opposed to smaller sizes. As long as the retail trade size is sufficiently small, the separating equilibrium prevails. In particular, we require that the expected payoff of an informed trader when placing a block order exceed the payoff from trading at smaller quantities, i.e., $\delta_\lambda(1+\psi) - s_t(q_t) > \xi\delta_\lambda(1+\psi)$ for all q_t, which is satisfied if the retail order size is sufficiently small.

[4] As we show later, it is only the liquidity motivations of the initial investors that are relevant for our results. One can generalize the model to allow the possibility of informed initial investors.

the possibility that an initial investor facing a liquidity shock on date 1 chooses to delay until date 2 to sell its block, in which case the investor incurs a delay cost $c_d > 0$. Furthermore, we assume that if the sale price from forced selling in the secondary market is less than a base price $\underline{p}$, the initial investor incurs a liquidation cost $c_\lambda > 0$. This assumption reflects the fact that institutional investors such as hedge funds or venture capitalists might in turn pay a penalty to their clients should returns fall below some minimum level.

An initial investor views the date t price as a random variable denoted by $\tilde{p}_t$. The public information set in period t is denoted by Φ_t. The expected payoff to an initial investor in the event of liquidation by the initial investors in date t, an event denoted by L_t, is $E[\tilde{p}_t \mid L_t, \Phi_t] - p_0(Q \mid \psi, R) - c_\lambda \Pr(\tilde{p}_t < \underline{p} \mid L_t, \Phi_t)$ minus the delay cost c_d if the liquidity shock occurs in period 1 and the investor delays before liquidating in period 2. Because we assume $|\delta_1| > |\delta_2|$, liquidity sales by the initial investors have a greater negative impact on price in period 1 than in period 2 and are more likely to depress the price below the threshold $\underline{p}$ in period 1 than in period 2, i.e., $E[\tilde{p}_2 \mid L_2, \Phi_1] > E[\tilde{p}_1 \mid L_1, \Phi_1]$ and $\Pr(\tilde{p}_1 < \underline{p} \mid L_1, \Phi_1) > \Pr(\tilde{p}_2 < \underline{p} \mid L_2, \Phi_1)$.

Lemma 1 Given c_λ, there exists $c_d' > 0$ such that for all $c_d < c_d'$, efficiency requires that after receiving a liquidity shock in period 1, initial investors delay until period 2 to liquidate.

Proof. See Appendix.

Lemma 1 provides the conditions under which it is efficient for initial investors to wait to liquidate if they receive a signal to sell in the first secondary trading round. However, in the absence of other incentives, initial investors may choose to liquidate in period 1 even when this is inefficient, i.e., it may be that c_d is sufficiently large that an individual prefers not to delay even though selling in period 1 imposes a negative externality on all the other liquidity traders in the form of an increased chance that they all incur the cost c_λ. Lemma 2 provides the conditions under which initial investors do not delay their trades.

Lemma 2 There exist $c'_d > c''_d > 0$ such that for all $c_d \in (c''_d, c'_d)$ efficiency requires that after receiving a liquidity shock in period 1, initial investors delay until period 2 to liquidate, but it is not a best reply for initial investors to delay.

Proof. See Appendix.

To focus on the interesting case, in what follows we assume that c_d and c_λ are in the ranges defined in Lemma 2. Thus, in the absence of other incentives, initial investors liquidate in the period in which they receive a liquidity shock.

2.2. Underpricing

The expected value of the stock of a type-ψ firm given public information is

$$E[v \mid \Phi_t] = \mu + \sum_{k=1}^{t-1} \delta_k (1+\psi) . \tag{3}$$

Because we assume no inventory or transaction costs, the bid-ask spread set by dealers for retail trades is zero. Thus, at time t, all retail orders (buys and sells) in a type-ψ firm transact at a price of $\mu + \sum_{k=1}^{t-1} \delta_k (1+\psi)$. However, for block orders, the size of the net trade is informative because of the potential presence of informed traders.

Anonymous market

In an anonymous market, where the underwriter is not a dealer, the expected price for a block at time t on date 1 for a type-ψ firm when there are q_t net block buys (negative if there are more sells than buys) is

$$p_t(q_t) \equiv \mu + \left(\sum_{k=1}^{t-1} \delta_k + E[\delta_t \mid q_t] \right) (1+\psi) . \tag{4}$$

Note that we define only the expected price $p_t(q_t)$ to avoid having to specify the order in which trades happen in period t.[5] Letting $s_t(q_t) \equiv E[\delta_t \mid q_t](1+\psi)$, then $s_t(q_t)$ is the expected price concession demanded by dealers to accommodate q_t net block buys. Note that $s_t(q_t)$ is positive if $q_t > 0$ and negative if $q_t < 0$.

At date 0, a potential IPO investor does not know whether it will be forced to liquidate its position early. Note that $E[s_t(q_t) \mid L_t, \Phi_0] < 0$, so defining s_t^b by

[5] We have in mind a model in which the dealers commit to a depth at each possible quote at the beginning of the period and then trades are executed at those quotes in random order.

$s_t^b \equiv | E[s_t(q_t) | L_t, \Phi_0] |$, then s_t^b is the expected price concession if the initial investors liquidate in period *t*. Letting $\rho_t \equiv \Pr(\tilde{p}_t < \underline{p} | L_t, \Phi_0)$, then ρ_t is the probability that the liquidation price in period *t* is below the initial investors' threshold. Applying the law of iterated expectations, we see that

$$E[\tilde{p}_t | L_t, \Phi_0] = E[E[v | \Phi_t] - s_t^b | \Phi_0] = E[v - s_t^b | \Phi_0] = \mu - s_t^b, \qquad (5)$$

It follows then that the investor's total expected payoff is $\mu - \sum_{t=1}^{2} \gamma_t (s_t^b + \rho_t c_\lambda) - p_0$.

For a client investor to participate in the IPO, the offer price must satisfy

$$p_0 = \mu - \pi, \qquad (6)$$

where $\pi = \sum_{t=1}^{2} \gamma_t (s_t^b + \rho_t c_\lambda)$.[6]

The term π represents the degree of underpricing that IPO investors require to participate in the offering. Thus, the offer price is the expected value of the security less a premium that is the product of the probability of early liquidation and the expected liquidation cost in terms of price impact and expected penalty from not meeting minimum liquidation needs. It is useful to contrast the following result with other explanations of IPO underpricing because it relies entirely on secondary market liquidity as an explanation for this phenomenon. Note that this explanation is in no way mutually exclusive to other, more traditional explanations for IPO underpricing.

Proposition 1: IPO underpricing given an anonymous secondary market is an increasing function of (a) firm risk, ψ, (b) the probability that initial investors liquidate their positions in period *t*, γ_t, and (c) the degree of asymmetric information in the after-market, measured by $\lambda - \omega$, where λ is the proportion of informed traders and ω is the proportion of liquidity traders.

Proof. See Appendix.

In addition to the relations noted in Proposition 1, IPO underpricing is increasing in the minimum liquidation requirement of the initial investors, $\underline{p}$, because ρ_t is increasing in $\underline{p}$.

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[6] Observe that even if there was a possibility that the initial investor were to receive subsequently a private information signal about a future value innovation at time *t*, equation (6) still holds. This is true because the investor can always trade in the secondary market on his information irrespective of his initial position and hence does not demand less of a premium to participate in the initial offer.

Relationship market

In contrast, in a relationship market, where the underwriter acts as the primary broker-dealer, the underwriter can offer a liquidating client a better price than that offered by competing broker-dealers, who do not know the client's reputation, and still make a profit. In fact, the underwriter is willing to trade with a liquidating client in period *t* at a price equal to $\mu + \sum_{k=1}^{t-1} \delta_k (1+\psi)$, so the clients anticipate a zero liquidity premium should they be forced to liquidate their initial positions early. Thus, if the issue size is sufficiently small that the underwriter can place all shares with member of its client base, who are known not to trade on information, then the offer price is $p_0 = \mu - \pi_{RM}$, where $\pi_{RM} \equiv \sum_{t=1}^{2} \gamma_t \Pr(\tilde{p}_t < \underline{p} \mid \Phi_0) c_\lambda$. A relationship market is more efficient than an anonymous market (see Proposition 2 below) because knowledge of client type reduces the probability that the clients incur the penalty from an insufficient liquidation value.

But if the offer size is large relative to the underwriter's client base, then the issue price is decided by the expected price concession faced by the *marginal* IPO investor, who is potentially informed because he/she is selected from outside the "vetted" pool of investors whose reputation is known to the underwriter from past dealings. The underwriter is willing to buy from this marginal IPO investor in period *t* at a price less than $\mu + \sum_{k=1}^{t-1} \delta_k (1+\psi)$ because of the possibility that this investor is informed. Specifically, in an anonymous market, the orders of informed investors are pooled with those of liquidity motivated traders, resulting in an expected price concession faced by the marginal investor of

$$(E[\delta_t \mid q_t, L_t] \Pr(L_t) + E[\delta_t \mid q_t, \sim L_t)(1 - \Pr(L_t)))(1+\psi).$$

In contrast, in a relationship market, the marginal IPO investor does not benefit from being pooled with liquidity traders because purely liquidity motivated traders are identified and separated out by the underwriter. Thus, the expected price concession faced by the marginal investor is greater in a relationship market than in an anonymous market, a reflection of the fact that in a relationship market the underwriter faces higher adverse selection costs in trading with this investor.

Thus, for sufficiently large issue sizes, the anonymous market is preferred over the relationship market by the additional initial investors. Although the expected cost of not meeting the minimum liquidation price increases for the underwriter's clients in the anonymous market, if that cost is sufficiently small, then the anonymous market dominates. This proves the following result.

Proposition 2: Given liquidation cost c_λ sufficiently small, there exists an issue size $\overline{Q}$ sufficiently large relative to the underwriter's client base such that for all issues sizes less (greater) than $\overline{Q}$, there is less (more) underpricing in a relationship market than an anonymous market structure. Furthermore, for small issue sizes, relationship market is more efficient than an anonymous market.

While the intuition of Proposition 2 is clear, it is worth noting that the result is only reinforced if the model is extended to include the strategic considerations we ignored for simplicity. In particular, in a relationship market, the market maker, by virtue of his knowledge of firm characteristics, has market power.[7] In our model, spreads are set at competitive levels, but when strategic pricing is considered, the application of this market power might lead to supra-normal bid-ask spreads. Specifically, the dealer might set spreads just below the level set by an uninformed dealer, thereby discouraging entry, but also yielding excess rents. By contrast, in an anonymous auction market, the dealer does not possess an informational monopoly and hence spreads are set at competitive levels. The competitive benefit from tighter spreads might offset the advantage of the relationship market for a large issue, where trading volumes are high, providing the same result as Proposition 2, albeit with a different logic.

These results establish the tradeoff between a relationship market and anonymous market for the entrepreneur. The choice affects liquidity in the secondary market, which affects the offer price, and thus underpricing.[8] The entrepreneur has preferences over the

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[7] See Ellis, Michaely, and O'Hara (2002) for evidence of market power by the dominant market maker.
[8] Given our assumptions, efficiency requires that when the initial investors receive a liquidity shock in period 1, they should wait until period 2 (until volatility has fallen) to liquidate. If the underwriter can credibly punish clients that liquidate in period 1, and if this is sufficient incentive for delay, then we say that there is an *informal lockup period*. In this case, the investor's total expected payoff is $\mu - \gamma_1 c_d - (\gamma_1 + \gamma_2)(s_2^b + \rho_2 c_\lambda) - p_0$. Letting $\pi_L \equiv \gamma_1 c_d + (\gamma_1 + \gamma_2)(s_2^b + \rho_2 c_\lambda)$, then π_L is the underpricing when there is an informal lockup period. Underpricing is lower with an informal lockup period than without if $s_1^b - s_2^b > c_d - (\rho_1 - \rho_2)c_\lambda$, which holds for c_d sufficiently small. This proves that *for c_d sufficiently small, an informal lockup period reduces underpricing*. The intuition for this result is that when the cost of delay c_d is small, this cost is outweighed by the benefit investors receive from the delay in liquidation trading to the period with lower volatility, in which case the negative externality imposed by each liquidity trader on the others is reduced.

degree of underpricing, and these preferences drive his decision between an anonymous market and a relationship market. We let this model guide the empirical work.

3 Empirical Design

Recall that R is a zero-one variable that represents the entrepreneur's choice of market. The entrepreneur's choice depends on a vector of exogenous variables Z, and we assume that it is positively related to a continuous latent variable $R^* = b(Z)$. If $R^* > 0$, then we observe $R = 1$, i.e., the choice of relationship market. Otherwise, $R = 0$, and an anonymous market is selected.

To capture the endogenous relationship between secondary market liquidity and underpricing, we write liquidity as $S = f(X_1; R; U(.))$ and underpricing as $U = f(X_2; R; S(.))$, where X_1 and X_2 are vectors of exogenous variables. We are interested in estimating the functions $S(.)$ and $U(.)$ simultaneously, but to obtain consistent estimates we must condition on the choice of market through $b(Z)$. To see this, write $S(.)$ and $U(.)$ as

$$S_i = \beta_s' X_{1i} + \delta_s' R_i + \kappa_s' U_i(.) + \varepsilon_i^s \text{, and}$$

$$U_i = \beta_u' X_{2i} + \delta_u' R_i + \kappa_u' S_i + \varepsilon_i^u ,$$

where ε^s and ε^u represent the disturbance terms that capture idiosyncratic factors affecting secondary market liquidity and underpricing, respectively. Taking expectations conditioned on the choice of the market, we have

$$E(S_i \mid R_i = 1) = \beta_s' X_{1i} + \delta_s + \kappa_s' E(U_i(.) \mid R_i = 1) + E(\varepsilon_i^s \mid R_i = 1) ,$$

$$E(S_i \mid R_i = 0) = \beta_s' X_{1i} + \kappa_s' E(U_i(.) \mid R_i = 0) + E(\varepsilon_i^s \mid R_i = 0) ,$$

$$E(U_i \mid R_i = 1) = \beta_u' X_{1i} + \delta_u + \kappa_u' E(S_i(.) \mid R_i = 1) + E(\varepsilon_i^u \mid R_i = 1) \text{, and}$$

$$E(U_i \mid R_i = 0) = \beta_u' X_{1i} + \kappa_u' E(S_i(.) \mid R_i = 0) + E(\varepsilon_i^u \mid R_i = 0) .$$

Defining the latent choice process, $R^* = \gamma' Z_i + \eta_i$, and exploiting the property of normal distributions, we have

$$E(\varepsilon_i^j \mid R_i = 1) = E(\varepsilon_i^j \mid \eta_i > -\gamma' Z_i)$$
$$= \rho\sigma_{e^j}\left(\frac{\phi(\gamma' Z_i)}{\Phi(\gamma' Z_i)}\right), \text{ and}$$
$$E(\varepsilon_i^j \mid R_i = 0) = E(\varepsilon_i^j \mid \eta_i <= -\gamma' Z_i)$$
$$= \rho\sigma_{e^j}\left(\frac{-\phi(\gamma' Z_i)}{1-\Phi(\gamma' Z_i)}\right)$$

where *j=(s, u),* ϕ(.) denotes the standard normal density function, Φ(.) denotes the standard normal cumulative distribution, and $\rho\sigma_e$ represents the covariance between ε and η (we assume $\sigma_\eta = 1$). The expected difference in liquidity and underpricing between firms that choose a relationship market and firms that choose an anonymous market then would be,

$$E(S_i \mid R_i = 1) - E(S_i \mid R_i = 0) = \delta_s + \kappa_s'\left(E(U_i(.) \mid R_i = 1) - E(U_i(.) \mid R_i = 0)\right)$$
$$+ \rho_{\eta,e^s}\sigma_{e^s}\left(\frac{\phi(\gamma' Z_i)}{\Phi(\gamma' Z_i)(1-\Phi(\gamma' Z_i))}\right)$$

and

$$E(U_i \mid R_i = 1) - E(U_i \mid R_i = 0) = \delta_u + \kappa_u'(E(S_i(.) \mid R_i = 1) - E(S_i(.) \mid R_i = 0))$$
$$+ \rho_{\eta,e^u}\sigma_{e^u}\left(\frac{\phi(\gamma' Z_i)}{\Phi(\gamma' Z_i)(1-\Phi(\gamma' Z_i))}\right).$$

The second and third terms on the right sides of the above two equations represent distortions or biases in our estimate of δ driven by the endogenous relation between secondary market liquidity and underpricing and self-selectivity ($\rho\sigma_e \neq 0$), respectively.

Following Heckman (1976, 1979), we use the inverse Mills' ratio (referred to as *Lambda*), which is $\left(\frac{\phi(\gamma' Z_i)}{\Phi(\gamma' Z_i)}\right)$ when $R_i = 1$, and $\left(\frac{-\phi(\gamma' Z_i)}{1-\Phi(\gamma' Z_i)}\right)$ when $R_i = 0$, as one of our regressors to mitigate the bias induced by self-selectivity. Further, we estimate the liquidity and underpricing equations simultaneously using a full-information maximum likelihood (FIML) procedure to correct for the endogeneity bias.[9]

We estimate our model in two stages: First, we estimate the latent selection process, R^*, by using its observed value, R, in a simple probit maximum likelihood

[9] We also estimate our simultaneous equations with selectivity using a two-stage least squares methodology but find results to be similar to those obtained using FIML.

procedure and compute the inverse Mills' ratio. Sec ond, we estimate underpricing and secondary market liquidity jointly using a FIML procedure in which we include the computed inverse Mills' ratio as one of our regressors. To alleviate concerns of multicollinearity, we ensure that not all exogenous variables from the first stage are included in our second stage.

4 Data and Sample Selection

In testing the model, we focus on the Nasdaq stock market. Comparing NYSE and Nasdaq stocks is problematic because the listing decision is compounded with many other factors (e.g., firm age, sector, etc.) that also affect the degree of underpricing. Indeed, for many years, new or IPO firms were discouraged from listing on the NYSE, and IPOs in listed stocks were usually spin-offs of larger, more established companies. In future work, we plan to include a matched sample of eligible NYSE listed stocks to the data.

We use the Securities Data Corporation's (SDC) data to identify all IPOs between the years 1996 to 2000 in the Nasdaq National Market System (NNM). Following Ellis, Michaely and O'Hara (2000), we exclude IPOs that have an offer price of less than $5, best-efforts offers, ADRs, unit offers, offers of securities other than common stock, REITs, partnerships and closed-end funds, as well as IPOs in the Nasdaq Small Cap Market. The SDC data provide information on the firm such as its ticker, name, cusip, and the four-digit SIC code under which it operates, as well as information on the IPO such as the offer date, the offer price, the number of shares offered, the primary listing market, whether the IPO was backed by venture capitalists, whether there exists an over-allotment (greenshoe) option, the fraction of the firm sold by insiders, and the identity of its lead underwriters.

Using proprietary data from the Nasdaq Stock Market, we identify the market maker with the highest market share for each IPO in the *third* month after the IPO. In Nasdaq, most underwriters dominate secondary market trading volume in Nasdaq IPOs soon after the IPO for reasons ranging from price support to marketing (see Ellis, Michaely and O'Hara (2000)). Pure market makers, such as Knight Securities, who do not have investment banking clients also provide liquidity in the secondary market (see, for example, Lucchetti (1998)). Examining market making three months after IPO helps us determine whether the underwriter stays on and commits capital to support the issue in its secondary market in the longer run. This period is also needed to avoid confusion with other underwriter activities, such as stabilization in the after-market. We use other cutoffs, such as six months to ensure the robustness of our inferences. We match the identity of the dominant market maker with the lead underwriter to determine whether the lead underwriter was active in providing secondary market liquidity.[10] We use only the lead underwriter (or lead underwriters if there are more than one), and not the entire underwriting syndicate, to establish dominance in market-making activity.

Since the reputation of underwriters could be a factor in both underpricing and market-making activity, we identify issues brought to the market by the top-five underwriters (Goldman Sachs, Merrill Lynch, Morgan Stanley Dean Witter, Salomon Smith Barney and Credit Suisse First Boston) to better capture reputation effects in our analyses. These underwriters were identified based on their market share using SDC data between 1996 and 2000.[11] Though the SDC data provides the first-day return for the IPO, we compute underpricing or the first-day return as the difference between the first-day closing price from CRSP and the offer price, as a percentage of the offer price. We also compute the first-day excess returns for each IPO as the difference between its first-day return and the market return. We use the CRSP value-weighted return of all Nasdaq stocks for Nasdaq IPOs as the market return. In addition, we use CRSP to determine the market capitalization at the end of three months and average monthly trading volume over the three months following the IPO. We obtain information about financial performance such as sales and profit of each firm in the year prior to their IPO from the Compustat database. We validate such information with SEC filing documents wherever possible.[12]

Since we examine the extent of the lead underwriter's market-making operations three months after the IPO, we use the percentage volume-weighted effective spread averaged over the first three months as our measure of secondary-market liquidity. This period is within the lockup period for most issues when insiders are restrained from

[10] Sometimes the lead underwriter would make markets through its market making subsidiary that may or may not be easy to match using just their names.
[11] If investment banks merged during this period, such as Dean Witter and Morgan Stanley, we consider their combined market share.
[12] We classify IPOs as being in the high-technology industry using a widely known standard. See http://www.aeanet.org/Publications/IDMK_definition.asp.

selling their holdings for informational reasons. Moreover, by using averages, we ensure that our liquidity measure is not influenced unduly by any action taken by the market maker to support prices in the short run. As mentioned before, we use alternative cut-offs, such as six months, to examine liquidity and the role of the lead underwriter to ensure robustness of our inferences. We also use other measures such as the average time-weighted quoted spread, average time-weighted inside depth, and share turnover (ratio of the average monthly volume over shares outstanding) to capture secondary-market liquidity.

5 Results and Discussion

We identify 1,152 Nasdaq IPOs between the years 1996 and 2000 that have the full information required for our analyses. Table 1 presents the frequency distribution and the underpricing of IPOs across the five years. There is substantial variation in the number of firms accessing public markets across years, with both 1996 and 1999 being hot IPO years. Interestingly, more than half of all IPOs in 2000 are in the first quarter, indicating the link between trends in the overall market and IPO activity.

Of the 1,152 IPOs, 705 IPOs (or 61 percent) have the lead underwriter as the dominant market maker three months after the IPO. Interestingly, the percentage of IPOs in which the lead underwriter is also the dominant market maker declines in more recent years (about 50 percent in 2000 as compared to 69 percent in 1996). This reflects the growing importance of wholesalers, such as Knight Securities, who specialize only in market making as opposed to traditional market-making firms who have extensive investment banking operations as well.

Underpricing, as a whole, is higher during 1999 and 2000 than during 1996 and 1997, reflecting the boom in technology and Internet IPOs. The average (median) underpricing was about 82.8 percent (49.6 percent) in 1999 while it was only 18.4 percent (10.5 percent) in 1996. However, there were clear differences in the level of underpricing depending on whether the lead underwriter was the dominant market maker in the secondary market or not. The mean (median) underpricing for IPOs where the lead underwriter was not the dominant market maker was 56.9 percent (20.5 percent) as compared to only 36.2 percent (14 percent) for IPOs where the underwriter and the dominant market maker were one and the same. We explore the importance of having the underwriter actively making a secondary market in greater detail later.

Table 2 presents differences in variables connected with the IPO such as offer price and size for the 705 Nasdaq IPOs where the lead underwriter was the dominant market maker in the secondary market and for the 447 IPOs where she was not the dominant market maker three months after the IPO. There is not much difference in the offer price and offer size between IPOs where the underwriter was the dominant market maker and IPOs where the underwriter was not the dominant market maker. The mean offer price was $12.99 for IPOs where the lead underwriter was the dominant market maker and $13.54 for IPOs where the lead underwriter was not the dominant market maker, while the mean offer size was 4.31 million shares and 4.28 million shares respectively.

Interestingly, venture capitalists (VCs) fund three out of five IPOs where the lead underwriter is not the dominant market maker as opposed to only one in two IPOs where the lead underwriter is also the dominant market maker. Moreover, insiders dilute lesser percentage of their holdings in IPOs when the lead underwriter is not the dominant market maker. This suggests that the need for a relationship market – where the underwriter also actively makes secondary markets – is greater when IPOs depend more on "outside" investors to succeed. Almost all IPOs provide for over -subscription during this period.

Though most firms lose money in the year before their IPO, firms where the underwriter also is the dominant market maker perform relatively better (with 20 percent more sales revenue and 50 percent lower losses) than firms where the underwriter is not the dominant market maker. However, they tend to be smaller and have lower trading volume on the first day of trading suggesting that smaller firms are more likely to be in a relationship market than larger firms.

Table 3 presents similar univariate comparisons in secondary market liquidity between IPOs where the lead underwriter is the dominant market maker and IPOs where she is not the dominant market maker. Our liquidity variables are averages over the first three months of trading following the IPO. We present four spread measures – time-weighted quoted spread, volume-weighted effective spread, and the percentage quoted and effective spreads and one market depth (the sum of shares sought at the bid and offered at the ask) measure to capture liquidity characteristics of the underlying stock. Moreover, we also present average monthly share volume and turnover along with the average closing price to capture trading interest in the stock. Though our spread measures (quoted and effective spread) reflect no major differences between firms where the lead underwriter was the dominant market maker and firms where the lead underwriter was not the dominant market maker, the latter are clearly more active and are turned over more than the former.

All our summary statistics reveal distinct differences in the characteristics of IPOs in which the lead underwriter eventually becomes the dominant market maker and IPOs in which they do not become the dominant market maker. These differences could arise from factors that affect the choice faced by the lead underwriter to make an active secondary market or not. Our analyses should therefore control for these factors before we make inferences on differences between a relationship market and an anonymous market. We discuss below the results from our two-stage estimation procedure that attempts to do exactly that.

Table 4 reports results from the first-stage probit maximum likelihood procedure, where the dependent variable is 1 if the lead underwriter is also the dominant market maker and 0 otherwise. Specifically, we estimate the following probit model:

$$\begin{aligned} R^* = {} & \delta_0 + \delta_1 LogProceeds + \delta_2 LogPrvSales + \delta_3 PrvyrProfit + \delta_4 Dilution \\ & + \delta_5 VCBacked + \delta_6 HiTech + \delta_7 NumLead + \delta_8 TopUW + \delta_9 Y97 \\ & + \delta_{10} Y98 + \delta_{11} Y99 + \delta_{12} Y00, \end{aligned}$$

$$R = 1 \text{ if } R^* > 0 \text{ and } R = 0 \text{ if } R^* \le 0,$$

where *LogProceeds* is the logarithm of gross proceeds of IPO, *LogPrvSales* is the logarithm of sales one year prior to the IPO, *PrvYrProfit* is the profit as a fraction of sales one year prior to the IPO, *Dilution* is the fraction of the firm sold by insiders at IPO, *VCBacked* indicates whether the IPO was backed by venture capitalists or not, *HiTech* is a dummy variable to denote the high-tech nature of the industry in which the firm operates, *NumLead* is the number of lead underwriters at IPO, *TopUW* is an indicator variable to denote whether the lead underwriter is among the top-five underwriters in market share, and four dummy variables, *Y*97, *Y*98, *Y*99 and *Y*00, to indicate each of the years 1997 to 2000.

These variables broadly characterize the nature of demand for external capital, the pre-IPO financial performance of a firm, and characteristics of the investment banks that choose to underwrite a firm's offering. We include year dummies to capture exogenous factors that may influence a firm's choice of a relationship market. The probit model has explanatory power, but possibly because of high correlation among the independent variables, only the number of lead underwriters and the dummy for IPOs in 1999 are statistically significant. We find that the probability that the lead underwriter makes an active secondary market decreases when the issue has multiple lead underwriters. Most IPOs have only one lead underwriter and the IPOs that have more than one are often large and well-followed in the market. Wholesalers can compete effectively for order flow for firms that are well-followed in the market. As shown in Table 1, the year 1999 was a hot IPO year and represented the peak of the Nasdaq stock market. Its statistical significance may simply reflect greater competition in market making for IPOs.

Based on the predicted probabilities of having the lead underwriter be the dominant market maker, we compute the inverse Mills' ratio (or *Lambda*) for each IPO. We estimate the following two models simultaneously using the full-information maximum likelihood procedure:

$$\begin{aligned}
E(Underpricing) = {} & \alpha + \beta_1 RelMkt + \beta_2 TopUW + \beta_3 LogProc + \beta_4 InvOffPrc \\
& + \beta_5 VCBacked + \beta_6 Y97 + \beta_7 Y98 + \beta_8 Y99 + \beta_9 Y00 + \beta_{10} Hitech \\
& + \beta_{11} PrvyrProfit + \beta_{12} Dilution + \beta_{13} Lambda + \beta_{14} E(Liquidity), \\
E(Liquidity) = {} & \varphi + \gamma_1 RelMkt + \gamma_2 InvCloPrc + \gamma_3 TopUW + \gamma_4 LogMarketCap \\
& + \gamma_5 Volume + \gamma_6 Lambda + \gamma_7 E(Underpricing).
\end{aligned}$$

Our main variable of interest is the dummy variable, *RelMkt*, which is the dependent variable, *R,* in the probit equation described above. If the fact that the lead underwriter is also the market maker has a significant effect, then the coefficient of *RelMkt* should be significant, as predicted by Proposition 1. Other exogenous variables in the two models are: *TopUW,* an indicator variable that is 1 if the lead underwriter is either Goldman Sachs, Merrill Lynch, Morgan Stanley Dean Witter, Salomon Smith Barney or Credit Suisse First Boston (the top-five underwriters by market share between 1996 and 2000), and zero otherwise; *LogProc,* the log of gross proceeds from the IPO; *InvOffPrc,* the inverse of the offer price; *VCBacked,* an indicator variable that is 1 if the

IPO is backed by venture capitalists and zero otherwise; the dummy variables *Y*97, *Y*98, *Y*99 and *Y*00 representing each of the years 1997 to 2000; *Hitech,* an indicator variable to indicate whether the IPO was from a firm in the high-tech industry; *PrvyrProfit,* the profit in the year prior to the IPO as a fraction of sales multiplied by 10^{-2}; *Dilution,* the fraction of the firm that is sold by the insiders at the IPO; *InvCloPrc,* the inverse of the closing price at the end of three months; *LogMarketCap,* the log of market capitalization in million dollars at the end of three months after IPO; *Volume,* the average monthly trading volume in the first three months after IPO in millions of shares; and *Lambda,* the inverse Mills ratio from the probit equation described above.

Table 5 presents results of our joint estimation of underpricing and effective spreads for Nasdaq IPOs between 1996 and 2000. After correcting for endogenous choice, *RelMkt* is negative and statistically significant in both the underpricing and effective spread regressions, indicating that IPOs in which the lead underwriter is the dominant market maker post-IPO are less underpriced and have lower transaction costs (or higher liquidity) than IPOs in which the lead underwriter is not the dominant market maker in the secondary market. This is consistent with the prediction of Proposition 1. Interestingly, IPOs underwritten by top underwriters trade at higher effective spreads in the first three months after IPO and are priced low at the offering, resulting in higher underpricing. This contrasts with results in earlier work that document lower underpricing for firms taken public by top underwriters.

After controlling for other factors, we find underpricing to be lower in each of the years until 1999, before it starts increasing in 2000. This contrasts with the unconditional increase in underpricing over time as shown in Table 1. This dichotomy suggests that the characteristics of firms seeking capital in the equity markets change dramatically from 1996 to 2000. Variables characterizing the issue such as *LogProc* and *InvOffPrc*, as well as those that determine the need for external capital such as *Dilution* and *VCBacked,* do not seem to have a significant impact on underpricing. However, we find a negative relationship between underpricing and effective spreads, or a positive relationship between underpricing and liquidity, after controlling for factors that include the endogenous choice of trading in a relationship market. This suggests that the finding of a positive relation between underpricing and spreads found by Ellul and Pagano (2002) in the case of British IPOs may be driven largely by the existence of relationships between underwriters and market makers in the UK. The coefficient of *Lambda* is positive and significant, indicating the presence of self-selectivity (captured by the first-stage probit procedure) that would have biased our results otherwise.

Although the results are consistent with our model, it is difficult to assess the economic importance of the results because the choice of market is endogenous. Given that the IPO sample is roughly split between the two market types, the effect on underpricing of market choice for the median IPO is presumably small. Accordingly, we estimate underpricing by market based on the estimated two-stage econometric model for representative values of the explanatory variables. Figure 2 plots the predicted underpricing (assuming Offer price = $15, Sales = $50M, Previous Year's Profit = -5%, Dilution = 15%, Effective spread = 2%, VC backed = yes, High Tech = yes, Number of Lead Underwriters = 1, Top Underwriter = 1, and Year = 2000) by market as a function of offer size. It is clear from the figure that the choice of market can have a considerable impact on underpricing. Indeed, for small offers of $50 million, underpricing in a relationship market is predicted to be 20.8% versus 36.3% in an anonymous market, a significant difference. By contrast, for an offer of $250million, underpricing in the relationship market is 39.1% versus 33.8% in the anonymous market. These results illustrate the economic importance of the choice of market in the IPO decision.

6 Conclusion

This paper examines the workings of so-called "relationship markets" for new equity issues, which are characterized by close economic links between corporations, investment bankers, public investors, and market makers. Although relationship markets are important for small stocks, there has not been a formal analysis of why they exist or what effects they may have on security prices. We develop a theoretical model to explain the stylized facts concerning both primary and secondary markets. We test the model using a two-stage endogenous-choice model with Nasdaq IPO data from the period 1996-2000.

Our results demonstrate that there is an important link between primary and secondary markets, especially in terms of liquidity and information flows. The organization or structure of the secondary market has an important effect on the primary market. Interestingly, our analysis provides a new explanation for underpricing. Even though our model presumes risk neutral investors, underpricing arises because of illiquidity for large-block trades in the secondary market that in turn reflects asymmetric information. Thus, we expect greater underpricing for smaller, more closely held firms without much analyst coverage. This dimension of underpricing is not likely to be a complete explanation in itself, but rather complements extant theories based on information.

We show that underpricing can be mitigated in a relationship market in which the lead underwriter is also the primary broker-dealer in secondary-market trading. The intuition for this result is as follows. In the process of going public, the underwriter successfully identifies clients whose motivations for trading are less likely to be information motivated than the overall population. For sufficiently small issues, the underwriter can offer these clients liquidity in the secondary market should they have to liquidate their positions early, and can provide better prices than a dealer who does not observe the investors' reputations. The ability to lay-off an initial position makes the stock more attractive to a potential IPO investor, raising the offer price.

In an anonymous secondary market structure, by contrast, the lead underwriter typically does not play a large role in secondary market trading. Hence liquidity cannot be assured to non-information-motivated clients. Thus, these clients face adverse selection costs in secondary market trading, inducing them to demand a lower offer price. Note that in theory, underwriters could offer such liquidity even in an anonymous structure, but this seems unlikely because they cannot themselves pass on their inventory without facing adverse selection costs.

The tradeoff between relationship and anonymous market structures differs for sufficiently large issues. For sufficiently large issues, an anonymous market structure, with a separation of underwriting and market making services, results in lower underpricing than a relationship market. This occurs because, for sufficiently large issues, the marginal IPO investor is typically not an existing client of the underwriter. In this case, the offer price is determined by this marginal investor, who demands less underpricing in an anonymous market because his trading costs are reduced in an anonymous market, relative to a relationship market – in an anonymous market, the trades of the marginal investor are pooled with those of liquidity-motivated traders, but in a relationship market, known liquidity traders are separated out by the underwriter.

The model can be extended in several directions. First, we would like to extend the model to incorporate another important feature of relationship markets, i.e., the role played by underwriters in promoting and marketing the stock. Analyst coverage and other efforts to promote the stock by encouraging trading by non-informed investors also alleviate underpricing. We conjecture that there will be less analyst coverage in an anonymous market than in a relationship market, other things equal, because the underwriter can use its initial research to subsidize its analysts. By contrast, analyst coverage in an anonymous market involves the costly duplication of research efforts that, in equilibrium, result in less coverage, less volume, and lower offer prices than in the relationship market.

An interesting extension of the model is the trade-off between bank and equity-based methods of financing. Research has shown that relationships play a crucial role in banking. Hence, it is natural to ask whether bank financing can overcome some of the difficulties faced by a firm that tries to raise equity. While relationship markets may provide a valuable option for companies that might otherwise face severe credit constraints, bank-based systems can alleviate the problems brought about by adverse selection.

Finally, it would be interesting to incorporate an endogenous switch from a relationship market to an anonymous market as firm size grows. Our results indicate that liquidity may be enhanced for sufficiently large firm sizes, suggesting that this may be a factor in decisions regarding exchange listing. These are topics for future research.

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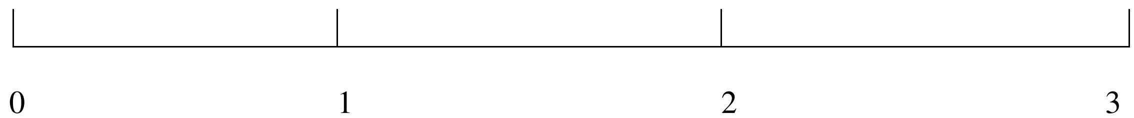

Firm selects optimal issue size and investment banker.

Underwriter contacts client investors and assigns analysts to cover stock.

Road show followed by public sale of securities.

Secondary market trading occurs in dates 1 and 2. Competitive market makers post quotes at the beginning of each round.

Informed trader may observe a value innovation in each round prior to trading.

Uninformed traders place orders; arrival rates are influenced by analyst coverage.

Initial investors may sell.

Project payoffs are realized.

Firm pays a liquidating dividend.

Figure 1: Time-Line

There are three dates in our model. At date 0, the firm decides on the IPO size and chooses the investment banker who will manage the issue both in the primary market (underwriting) as well as the secondary market (market making). There is trading at dates 1 and 2 that capture the secondary market for the stock. Apart from the initial IPO investors, other traders, both informed and uninformed, can trade in these rounds. Competitive market makers post quotes at the beginning of each round. The firm is liquidated at date 3.

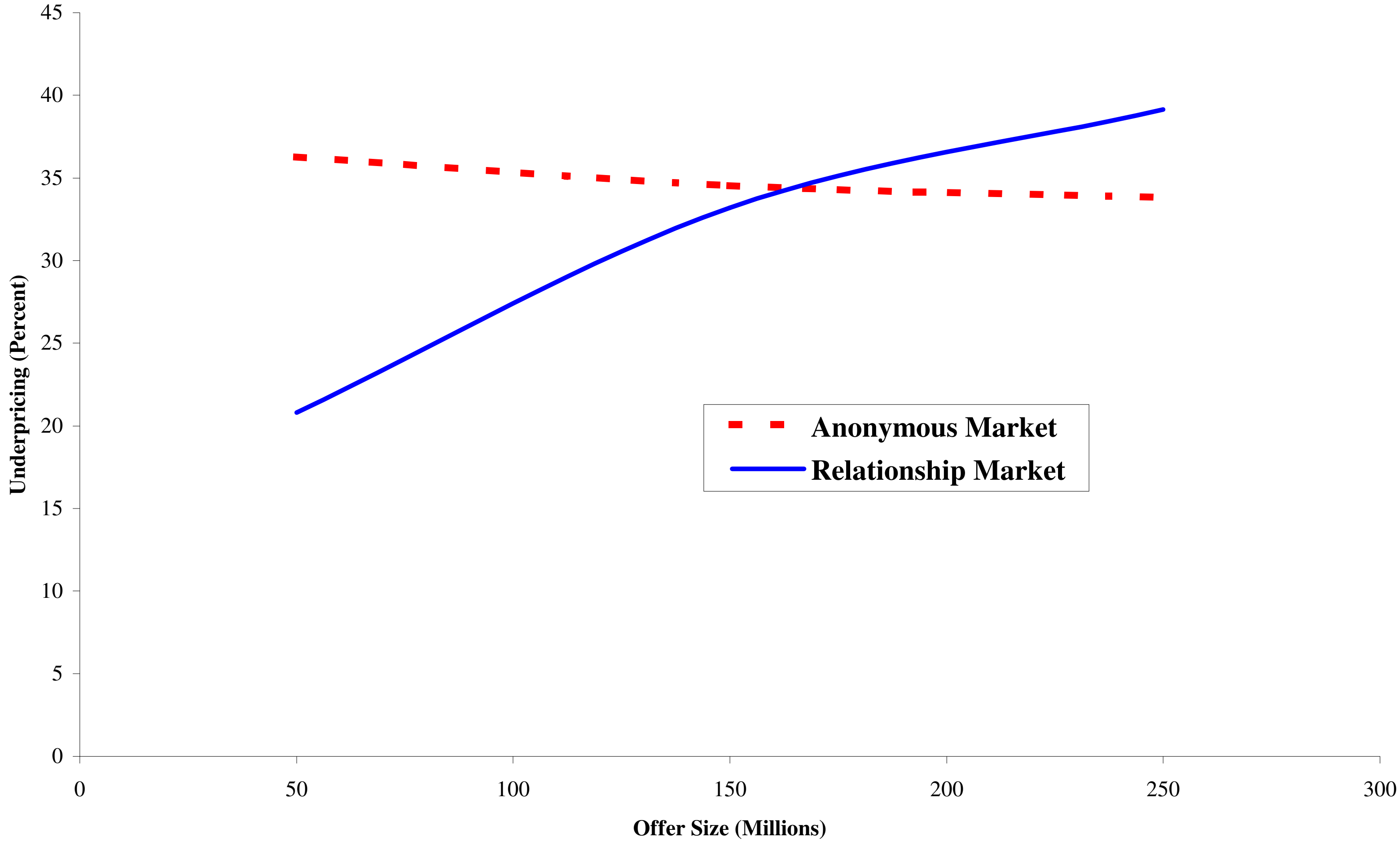

Figure 2: Underpricing By Market as a Function of Offer Size

The figure plots underpricing by market based on the estimated two-stage econometric model assuming the following values for the variables: Offer price = $15, Sales = $50M, Previous Year's Profit = –5%, Dilution = 15%, Effective spread = 2%, VC backed = yes, High Tech = yes, Number of Lead Underwriters = 1, Top Underwriter = 1, and Year = 2000.

Table 1
Descriptive Statistics for Our Sample

The table provides descriptive statistics on Nasdaq IPOs between 1996 and 2000. IPOs were identified using the Securities Data Corporation (SDC) database. We exclude IPOs that have an offer price of less than $5, best-efforts offers, ADRs, unit offers, offers of securities other than common stock, REITs, partnerships, closed-end funds, and IPOs listed on Nasdaq Small Cap Market. We define the dominant market maker of the security as the market maker with the highest market share. Underpricing is computed as the difference between the first-day closing price from CRSP and the offer price, as a percentage of the offer price.

Offer Year	All IPOs			Is the lead underwriter also the dominant market maker three months after IPO?							
				No				Yes			
	Number of IPOs	Underpricing (%)		Number of IPOs		Underpricing (%)		Number of IPOs		Underpricing (%)	
	N	Mean	Median	N	%	Mean	Median	N	%	Mean	Median
1996	316	18.4	10.5	99	31	19.3	11.4	217	69	18.0	10.0
1997	234	15.5	10.0	71	30	16.3	11.5	163	70	15.2	8.9
1998	132	29.0	12.4	47	36	51.6	17.7	85	64	16.5	9.2
1999	313	82.8	49.6	151	48	95.4	50.0	162	52	71.0	48.8
2000	157	74.7	49.0	79	50	69.9	50.9	78	50	79.4	45.6
All	1,152	44.2	17.5	447	39	56.9	20.5	705	61	36.2	14.0

Table 2

Summary Statistics for IPO-Related Variables

The table provides summary statistics for variables associated with Nasdaq IPOs between 1996 and 2000. IPOs were identified using the SDC database. We exclude IPOs that have an offer price of less than $5, best-efforts offers, ADRs, unit offers, offers of securities other than common stock, REITs, partnerships, closed-end funds, and IPOs listed on the Nasdaq Small Cap Market. We report the cross-sectional averages along with the medians in parentheses. We define the dominant market maker of the security as the market maker with the highest market share. Underpricing is computed as the difference between the first-day closing price from CRSP and the offer price, as a percentage of the offer price. We compute the first-day excess returns for the IPO as the difference between its first-day return and the market return. We use the CRSP value-weighted return of all NYSE stocks for NYSE IPOs and the CRSP value-weighted return of all Nasdaq stocks for Nasdaq IPOs as the market return. Income and sales figures are obtained from Compustat and from firms' SEC filing statements. First-day trading volume and market capitalization figures are obtained using CRSP. All other variables are from the SDC database. The t-statistic is computed under the assumption of unequal variances. An asterisk indicates significance at the 5% level.

Variable (1)	N (2)	Is the lead underwriter also the dominant market maker three months after the IPO?		T-statistic under the null that the difference between columns (3) and (4) is equal to zero (5)
		No (3)	Yes (4)	
Offer price ($)	1,152	13.54 (13.00)	12.99 (12.00)	1.82
Offer shares (in million shares)	1,152	4.28 (3.75)	4.31 (3.25)	-0.11
Percentage of venture-backed IPOs	1,152	62.0 (100.0)	51.1 (100.0)	3.67*
Dilution percentage by insiders at IPO	1,084	14.4 (12.6)	18.0 (15.7)	-3.15*
Percentage of IPOs with green-shoe option	1,152	94.6 (100.0)	97.0 (100.0)	-1.92

Table 2 (Continued)

Variable (1)	N (2)	Is the lead underwriter also the dominant market maker three months after the IPO?		T-statistic under the null that the difference between columns (3) and (4) is equal to zero (5)
		No (3)	Yes (4)	
Sales in the year prior to IPO (in $M)	1,091	42.17 (13.28)	51.02 (18.91)	-1.19
Income in the year prior to IPO (in $M)	1,089	-6.68 (-3.78)	-3.23 (-0.44)	-3.77*
First-day underpricing (%)	1,152	56.88 (20.46)	36.16 (14.00)	4.20*
First-day excess returns (%)	1,152	56.65 (21.34)	36.04 (14.52)	4.18*
First-day trading volume (in millions of shares)	1,152	4.70 (2.84)	3.74 (2.21)	2.95*
First-day market capitalization (in millions of dollars)	1,152	769.61 (266.41)	523.83 (177.49)	1.72

Table 3

Summary Statistics for Secondary Market Liquidity Variables

The table provides summary statistics for variables that measure secondary market liquidity of Nasdaq IPOs between 1996 and 2000. IPOs were identified using the SDC database. We exclude IPOs that have an offer price of less than $5, best-efforts offers, ADRs, unit offers, offers of securities other than common stock, REITs, partnerships, closed-end funds, and IPOs listed on the Nasdaq Small Cap market. We report the cross-sectional averages along with the medians in parentheses. We define the dominant market maker of the security as the market maker with the highest market share. All our liquidity measures are computed for the first three months of trading following the IPO using the TAQ database. We use CRSP to get data on shares outstanding. The quoted spread is the difference between the offer and bid prices. The percentage quoted spread is the quoted spread as a percentage of the quote midpoint. The effective spread is twice the absolute difference between the trade price and the quote midpoint. The percentage effective spread is the effective spread as a percentage of the quote midpoint. Depth is the sum of shares (in round lots) sought at the bid and offered at the ask price. The t-statistic is computed under the assumption of unequal variances. An asterisk indicates significance at the 5% level.

Variable (1)	N (2)	Is the lead underwriter also the dominant market maker three months after IPO?		T-statistic under the null that the difference between columns (3) and (4) is equal to zero (5)
		No (3)	Yes (4)	
Average time-weighted quoted spread (in $)	1,152	0.44 (0.34)	0.55 (0.36)	-1.62
Average time-weighted percentage quoted spread	1,152	2.60 (2.14)	2.78 (2.49)	-1.66
Average volume-weighted effective spread (in $)	1,152	0.32 (0.27)	0.32 (0.27)	-0.11
Average volume-weighted percentage effective spread	1,152	1.93 (1.51)	2.10 (1.72)	-1.53

Table 3 (Continued)

Variable (1)	N (2)	Is the lead underwriter also the dominant market maker three months after IPO?		T-statistic under the null that the difference between columns (3) and (4) is equal to zero (5)
		No (3)	Yes (4)	
Average depth (in round lots)	1,152	5.73 (5.27)	5.76 (5.44)	-0.17
Average monthly share volume (in millions of shares)	1,152	5.87 (3.36)	3.38 (1.95)	5.71*
Average share turnover (monthly volume/shares outstanding)	1,151	245.42 (160.20)	170.06 (135.95)	4.81*
Average closing price ($)	1,152	28.85 (16.42)	25.81 (14.50)	0.58

Table 4

Probit Model of the Choice of a Relationship Market

This table presents results of a simple probit model in which the dependent variable is whether the underwriter of a security is the dominant market maker in its secondary market three months after the IPO. We define the market maker to be dominant if she has the highest market share. We use all Nasdaq IPOs between 1996 and 2000 except IPOs that have an offer price of less than $5, best-efforts offers, ADRs, unit offers, offers of securities other than common stock, REITs, partnerships, closed-end funds, and IPOs listed on the Nasdaq Small Cap Market. The model we estimate is:

$$R^* = \delta_0 + \delta_1 LogProceeds + \delta_2 LogPrvSales + \delta_3 PrvyrProfit + \delta_4 Dilution + \delta_5 VCBacked + \delta_6 HiTech + \delta_7 NumLead + \delta_8 TopUW + \delta_9 Y97 + \delta_{10} Y98 + \delta_{11} Y99 + \delta_{12} Y00,$$

$$R = 1 \text{ if } R^* > 0 \text{ and } R = 0 \text{ if } R^* \leq 0.$$

The dependent variable, *R*, is an indicator variable that is 1 if the lead underwriter is also the dominant market maker and zero otherwise. The exogenous variables that determine the choice of a relationship market are: *LogProceeds*, the log of gross proceeds from the IPO, *LogPrvSales*, the log of sales in the year prior to the IPO, *PrvyrProfit*, the profit in the year prior to the IPO as a fraction of sales multiplied by 10^{-2}, *Dilution*, the fraction of the firm that is sold by the insiders at the IPO, *VCBacked*, an indicator variable that is 1 if the IPO is backed by venture capitalists and zero otherwise, *HiTech*, an indicator variable for whether the IPO was from a firm in the high-tech industry (see Appendix B), *NumLead*, the number of lead underwriters, *TopUW*, an indicator variable that is 1 if the lead underwriter is either Goldman Sachs, Merrill Lynch, Morgan Stanley Dean Witter, Salomon Smith Barney or Credit Suisse First Boston, and zero otherwise, and the dummy variables *Y*97, *Y*98, *Y*99 and *Y*00 representing each of the years 1997 to 2000. An asterisk indicates significance at the 5% level.

Dependent variable = Relationship Market Indicator

Variable	Estimate	Standard Error
Intercept	1.47	1.25
LogProceeds	-0.03	0.07
LogPrSales	0.05	0.03
PrvyrProfit	0.08	0.16
Dilution	0.60	0.35
VCBacked	-0.07	0.09
HiTech	-0.09	0.09
NumLead	-0.63*	0.20
TopUW	0.06	0.10
Y97	0.14	0.13
Y98	-0.10	0.15
Y99	-0.26*	0.12
Y00	-0.22	0.15

Table 5

Models of IPO Underpricing and Secondary Market Liquidity

We present results of a full-information maximum-likelihood estimation of IPO underpricing and secondary market liquidity, controlling for the endogenous choice of the relationship market. We estimate the two models simultaneously after including the inverse Mills' ratio (*Lambda*) from our choice model of the relationship market (see Table 4) as one of our regressors. The models are:

$$E(\mathit{Underpricing}) = \alpha + \beta_1 \mathit{RelMkt} + \beta_2 \mathit{TopUW} + \beta_3 \mathit{LogProc} + \beta_4 \mathit{InvOffPrc} + \beta_5 \mathit{VCbacked} + \beta_6 Y97 + \beta_7 Y98 + \beta_8 Y99 + \beta_9 Y00 + \beta_{10} \mathit{Hitech} + \beta_{11} \mathit{PrvyrProfit} + \beta_{12} \mathit{Dilution} + \beta_{13} \mathit{Lambda} + \beta_{14} E(\mathit{Liquidity})$$

$$E(\mathit{Liquidity}) = \varphi + \gamma_1 \mathit{RelMkt} + \gamma_2 \mathit{InvCloPrc} + \gamma_3 \mathit{TopUW} + \gamma_4 \mathit{LogMarketCap} + \gamma_5 \mathit{Volume} + \gamma_6 \mathit{Lambda} + \gamma_7 E(\mathit{Underpricing}).$$

The exogenous variables in the two models are: *RelMkt*, an indicator variable that is 1 if the lead underwriter is also the dominant market maker three months after IPO and zero otherwise, *TopUW,* an indicator variable that is 1 if the lead underwriter is either Goldman Sachs, Merrill Lynch, Morgan Stanley Dean Witter, Salomon Smith Barney or Credit Suisse First Boston, and zero otherwise, *LogProc,* the log of gross proceeds from the IPO, *InvOffPrc,* the inverse of the offer price, *VCBacked,* an indicator variable that is 1 if the IPO is backed by venture capitalists and zero otherwise, the dummy variables *Y*97, *Y*98, *Y*99 and *Y*00 representing each of the years 1997 to 2000, *Hitech,* an indicator variable for whether the IPO was from a firm in the high-tech industry (see Appendix B), *PrvyrProfit,* the profit in the year prior to the IPO as a fraction of sales multiplied by 10^{-2}, *Dilution,* the fraction of the firm that is sold by the insiders at the IPO, *InvCloPrc,* the inverse of the closing price at the end of three months, *LogMarketCap,* the log of market capitalization in million dollars at the end of three months after the IPO, *Volume,* the average monthly trading volume in the first three months after IPO in millions of shares, and *Lambda,* the inverse Mills' ratio from the probit equation of Table 4. We use the IPO's first-day return to measure underpricing, and we use the percentage volume-weighted effective spread to measure secondary-market liquidity. The liquidity measure is computed as the monthly average over the first three months of trading of the IPO. An asterisk indicates significance at the 5% level.

Dependent variable: Underpricing

Parameter	Estimate	Standard Error
Intercept	138.91*	66.56
RelMkt	-199.64*	38.00
TopUW	24.88*	8.68
LogProc	6.11	3.57
InvOffPrc	50.84	63.30

Table 5 (Continued)

Dependent variable: Underpricing

Parameter	Estimate	Standard Error
VCBacked	-4.73	3.60
Y97	-10.72	5.75
Y98	-18.82*	8.79
Y99	-24.96*	12.66
Y00	-6.65	5.54
HiTech	-0.98	3.18
PrvYrProfit	2.99	4.13
Dilution	-5.42	10.55
Lambda (Inverse Mills' Ratio)	117.88*	24.33
Liquidity (Percentage volume-weighted effective spread)	-36.78*	3.73

Dependent variable: Percentage Volume-Weighted Effective Spread

Parameter	Estimate	Standard Error
Intercept	8.47*	2.16
RelMkt	-11.26*	4.88
InvCloPrc	-13.02	10.47
TopUW	1.45*	0.67
LogMarketCap	0.80	0.61
Volume	-0.07	0.05
Lambda (Inverse Mills' Ratio)	6.50*	2.78
Underpricing	-0.07*	0.03

Appendix

***Proof of Lemma* 1.** Assuming initial investors either all liquidate in period 1 or all liquidate in period 2, efficiency requires delay if, given the information available in period 1, investors' expected payoffs are greater if they wait to liquidate in period 2 than if they liquidate in period 1:

$$E[\tilde{p}_1 \mid L_1, \Phi_1] - c_\lambda \Pr(\tilde{p}_1 < \underline{p} \mid L_1, \Phi_1) < E[\tilde{p}_2 \mid L_2, \Phi_1] - c_\lambda \Pr(\tilde{p}_2 < \underline{p} \mid L_2, \Phi_1) - c_d .$$

The proof follows by letting

$$c_d' \equiv E[\tilde{p}_2 \mid L_2, \Phi_1] - E[\tilde{p}_1 \mid L_1, \Phi_1] - c_\lambda (\Pr(\tilde{p}_2 < \underline{p} \mid L_2, \Phi_1) - \Pr(\tilde{p}_1 < \underline{p} \mid L_1, \Phi_1)),$$

which is positive. Q.E.D.

***Proof of Lemma* 2.** Let c_d' be as in the proof of Lemma 1. Suppose $c_d \le c_d'$ so that by Lemma 1, delay is efficient. Consider initial investor *x*. Let *X* be the event that other initial investors liquidate in period 2, but investor *x* liquidates in period 1. If investor *x* sells in period 1, its expected payoff is $E[\tilde{p}_1 \mid X, \Phi_1] - p_0 - c_\lambda \Pr(\tilde{p}_1 < \underline{p} \mid X, \Phi_1)$. If investor *x* sells in period 2, its expected payoff is $E[\tilde{p}_2 \mid L_2, \Phi_1] - p_0 - c_\lambda \Pr(\tilde{p}_2 < \underline{p} \mid L_2, \Phi_1) - c_d$. Thus, delay is not a best reply for investor *x* if $c_d'' < c_d$, where $c_d'' \equiv E[\tilde{p}_2 \mid L_2, \Phi_1] - E[\tilde{p}_1 \mid X, \Phi_1] - c_\lambda (\Pr(\tilde{p}_2 < \underline{p} \mid L_2, \Phi_1) - \Pr(\tilde{p}_1 < \underline{p} \mid X, \Phi_1))$. Note that $c_d'' < c_d'$ if and only if $c_\lambda > \dfrac{E[\tilde{p}_1 \mid L_1, \Phi_1] - E[\tilde{p}_1 \mid X, \Phi_1]}{\Pr(\tilde{p}_1 < \underline{p} \mid L_1, \Phi_1) - \Pr(\tilde{p}_1 < \underline{p} \mid X, \Phi_1)}$. Since the right side of this inequality is negative, it always holds. Q.E.D.

***Proof of Proposition* 1.** Clearly $\sum_{t=1}^{2} \gamma_t (s_t^b + \rho_t c_\lambda)$ is increasing in γ_1 and γ_2. We must show that it is increasing in ψ and in $\lambda - \omega$. To see that it is increasing in ψ note that $s_t^b = \mid E[s_t(q_t) \mid L_t, \Phi_0] \mid$ and $\rho_t = \Pr\left(\tilde{p}_t < \underline{p} \mid L_t, \Phi_0\right)$ are increasing in ψ. To see that s_t^b and ρ_t are increasing in $\lambda - \omega$, note that $\Pr(\delta_t = \delta_\lambda \mid q_t < 0)$ is increasing in λ given ω and decreasing in ω given λ. Q.E.D.