Underpricing and Entrepreneurial Wealth Losses in IPOs: Theory and Evidence

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We model owners as solving a multidimensional problem when taking their firms public. Owners can affect the level of underpricing through the choices they make in promoting an issue, such as which underwriter to hire or on what exchange to list. The benefits of reducing underpricing in this way depend on the owners' participation in the offering and the magnitude of the dilution they suffer on retained shares. We argue that the extent to which owners trade off underpricing and promotion is determined by the minimization of their wealth losses. Evidence from a sample of U.S. initial public offering confirms our empirical predictions.

Why are some initial public offerings (IPOs) more underpriced than others? For instance, why do IPOs by companies with dot-com in their names suffer average underpricing that is nearly eight times the U.S. average of 13%? Why are Chinese IPOs underpriced by 42%, whereas Malaysian IPOs are underpriced by 6%? And why has average underpricing in Germany quadrupled since the introduction of the *Neuer Markt* in March 1997?[1]

The theoretical literature on IPO underpricing suggests a number of possible answers: Some IPOs are more underpriced than others because there is

[1] Averages quoted are based on Jenkinson, et al. (1999) and Securities Data Corporation data.

greater asymmetry of information, more valuation uncertainty, greater risk of lawsuits, and so on.[2]

Although we do not deny that any or all these factors may be at work, we suggest a more fundamental, non–mutually exclusive reason: Some IPOs are more underpriced than others because their owners have less reason to care about underpricing. We argue that the extent to which owners care about underpricing depends on how much they sell at the IPO.[3] Owners who sell very few shares suffer only marginally from underpricing. Conversely, the more shares they sell, the greater their incentive to decrease underpricing. As a consequence, we expect that the degree of equilibrium underpricing depends on the extent of insider selling. To return to our examples, the owners of a typical U.S. IPO sell nearly 5 times more equity than the average dot-com IPO; Malaysian owners sell 58 times more equity in IPOs than do their Chinese counterparts; and the companies going public on Germany's *Neuer Markt* sell only half as much equity as do companies on Germany's more established marketplaces.

Controlling for the owners' incentives to decrease underpricing in turn helps us understand the choices they make when going public. To illustrate, in the U.S. and Canada issuers can choose between a best-efforts offering (which is cheap in terms of cash expenses but typically leads to high under-pricing) and a firm-commitment book-building (which is expensive in terms of fees but leads to lower underpricing). Similarly, a German high-tech company can choose to go public domestically, or obtain a listing on NASDAQ, which will cost more but may result in lower underpricing if U.S. banks and investors are better able to value high-tech companies. Issuers can choose to hire a top-flight investment bank, at a higher fee, and benefit from the quality certification such a bank may provide, or they can hire the cheapest bank available.[4] They can similarly choose different auditors or lawyers based on reputation and certification considerations and different levels of voluntary disclosure based on competitive considerations.[5]

These examples highlight that issuers can, to some extent, make costly choices that lead to lower expected underpricing. In other words, there may be trade-offs between what we label the promotion costs of going public and

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[2] For a survey of these and other reasons for underpricing, see Jenkinson and Ljungqvist (1996). Of course, internet IPOs could be more underpriced due to hype, Chinese IPOs due to political risk, and German IPOs due to a change in the type of business taken public.

[3] How much owners care about underpricing also depends on how many new shares they issue at the IPO, because new shares sold at a discount dilute the owners' stake. For ease of exposition, we mainly discuss the sale of old shares in this introduction. Our formal analysis considers both new and old shares.

[4] Dunbar (2000) shows that U.S. banks that cut their fees gain market share, indicating that issuers are at least partly influenced in their underwriter choice by the fees they are quoted. Interestingly, he also finds that top-flight banks can gain market share despite charging abnormally high fees, indicating that issuers expect some offsetting benefit from hiring such banks.

[5] Palmiter (1999) notes in his abstract, "There is strong evidence that...issuers...disclose at levels beyond that mandated [by the Securities Act of 1933]—as a private, contractual matter."

underpricing. Combining this view with our claim that issuers care about underpricing primarily to the extent that they participate in the offering, we predict that issuers rationally decide to spend more when going public, the more they plan to sell at the IPO. Thus, firm-commitment offerings should, on average, be most attractive for larger issues; a NASDAQ listing will appeal to German high-tech entrepreneurs who plan to cash out; hiring a top-flight investment bank or auditor will be worthwhile for larger issues; and greater voluntary disclosure will be desirable if the benefit from lower underpricing outweighs the competitive disadvantage.

In this article, we formalize, develop, and test the ideas that underlie the preceding discussion. There are two main premises to our analysis. The first is that owners care about underpricing to the extent that they stand to lose from it, and that any such losses are proportional to the number of primary (new) and secondary (old) shares being sold. The second is that issuers can affect the level of underpricing by promoting their issues. We assume that issuers choose between different promotion strategies as illustrated in our previous examples. It is clearly impracticable to attempt to capture all the various possible combinations of promotion strategies, such as underwriter, auditor, and lawyer reputations; target investment audience; extent of road shows; multiple listings possibly in different countries; and so on. Instead, we measure the total cost of each issuer's chosen promotion strategy and compare this cost across issuers. Total promotion costs include the fees paid to underwriters, auditors and lawyers; the cost of road shows; listing fees; and so on, but exclude management time, which cannot easily be measured.[6]

For promotion costs to affect underpricing presumes that promoting an issue can be an alternative to underpricing the issue. This was recognized more than a decade ago by Allen and Faulhaber (1989), Booth and Smith (1986), Carter and Manaster (1990), and Welch (1989). Although their focus was on signaling issue quality through underpricing, Allen and Faulhaber (1989, p. 305) and Welch (1989, pp. 438–439) noted in passing that signaling could also be accomplished through the choice of underwriter and auditor and through advertising, respectively. Carter and Manaster (1990) derived and tested an inverse relation between underpricing and underwriter reputation,[7] which combined Beatty and Ritter's (1986) inverse relation between underpricing and issue quality with Titman and Trueman's (1986) positive relation between issue quality and underwriter reputation. Finally, Booth and Smith (1986, p. 267) specifically discussed the trade-off between the cost of certifying an issue's quality and underpricing: "The more costly is external certification relative to the benefit, the more likely the stock or risky debt to

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[6] Promotion costs exclude the cost of the underwriting cover, which is a compensation for risk. We return to this distinction in Section 2.

[7] This inverse relation has recently been questioned by Beatty and Welch (1996), who found a positive relation between underpricing and underwriter reputation in the 1990s. We reexamine this issue in Section 3.3.

be issued at a discount. The underwriter will incur direct costs of certification only to the point where marginal cost of certification equals marginal benefit so that net issue proceeds are maximized."

Generalizing Booth and Smith's point, we can view promotional activities and underpricing as substitutes. Issuers are then faced with a multidimensional problem when taking a firm public. In addition to the level of underpricing, issuers must choose an optimal promotion strategy, which involves deciding which underwriter and auditor to choose and how much to spend on advertising, as well as all the other promotional activities that may help reduce underpricing.[8] We examine the optimal mix of these activities and show how the choice between underpricing and promotion varies with the number of primary and secondary shares sold at the offering.

We use a simple model based on Benveniste and Wilhelm's (1990) adaptation of the Rock (1986) model to analyze the problem.[9] Our purpose in using a formal model is twofold. First, we use the model to verify our main intuition, specifically that issuers will incur greater promotion costs when selling more shares. An issuer selling more shares clearly stands to lose more than an issuer selling fewer shares for a given level of underpricing. The former therefore has a greater incentive to incur the promotion costs that we argue decrease underpricing. In the Rock (1986) model, underpricing is necessary to induce uninformed investors to take part in the offering despite the adverse selection problem introduced by the presence of informed investors. Promoting the issue serves to increase the fraction of uninformed investors taking part in the offering [Carter and Manaster (1990)]. Promoting the issue therefore decreases the extent of the adverse selection problem, thereby decreasing the necessary amount of underpricing.[10]

Second, we use the model to derive a number of testable implications and optimality restrictions. Some testable implications are very intuitive. For example, as noted above, promotion costs should increase in the number of shares sold. Incurring these promotion costs is worthwhile only if they decrease underpricing. Underpricing should therefore decrease in promotion costs. Other testable implications are less intuitive. Consider how underpricing varies with the number of shares sold. Our earlier discussion suggests that the incentive to reduce underpricing should be greater for issuers selling more shares. Therefore, the optimal combination of underpricing and promotion should involve higher promotion costs and lower underpricing for large issues than for small issues. This intuition implies that underpricing should

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[8] Of course, the choice of underwriter is not entirely at the discretion of the issuer, for the underwriter may refuse to take part in the offering. But the fact remains that the issuer has some choice in choosing an underwriter. For evidence of such choice, see Dunbar (2000) and note 4.

[9] We note that our use of the Rock (1986) adverse selection rationale for underpricing is without loss of generality. All that is needed for our argument to hold is (i) a reason for underpricing and (ii) one or more alternatives to underpricing.

[10] We formalize this argument in Section 1.

decrease in the number of shares sold. However, there are possibly offsetting effects, depending on the origin of the shares sold. Where the IPO consists of primary shares, the costs of promotion are borne by the company in the first instance, thereby reducing both the aftermarket share price and the offer price by the same amount. But because most IPOs are underpriced, the offer price is reduced by more in percentage terms than is the aftermarket share price, resulting in greater underpricing. This second effect works in the opposite direction to the first effect whose intuition we described earlier. Where the IPO consists of secondary shares, there is no second effect because the costs are borne by the selling shareholders. Mixed offerings are more complicated. Tracing these effects cannot easily be achieved in the absence of a formal model.

The optimization problem faced by the issuer imposes testable restrictions on the regression equations we derive. We claim that the issuer acts to minimize wealth losses from going public. These equal the sum of the promotion costs incurred and the losses from underpricing and dilution and should be minimized through the choice of promotion costs.[11] An increase in promotion costs has two effects on wealth losses: (i) a direct effect, which increases wealth losses as promotion costs are part of wealth losses; and (ii) an indirect effect, which decreases wealth losses by decreasing underpricing. Optimality requires these two opposing effects to be equal at the margin. It therefore restricts the coefficient of a regression of wealth losses on promotion costs to be zero.

Our empirical findings support the predictions of our model. Using a large sample of U.S. IPOs from 1991 to 1995, we find that underpricing decreases in promotion costs, and promotion costs increase in the number of shares sold. Furthermore, underpricing decreases in insider selling, as suggested by our earlier discussion of dot-com IPOs. We also find that issuers in our sample are optimizing: At the margin, each dollar spent on promotion reduces wealth losses by 98 cents, indicating that the marginal cost of promotion equals the marginal benefit of reduced wealth losses. Finally, we show that a particular dimension of issuers' promotion strategy, the choice of underwriter, is related to how many shares are sold. Not controlling for this endogeneity of underwriter choice seriously biases the estimated effect of underwriter reputation on underpricing, which seems to account for the counterintuitive positive relation between underpricing and underwriter reputation recently documented by Beatty and Welch (1996) and others. We conduct numerous robustness checks, which leave our basic results unchanged.

In light of our results, we argue that recognizing issuers' ability, and incentives, to make choices when going public matters. Consider an empirical test

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[11] For a discussion of the difference between underpricing and wealth losses, see Barry (1989) and Brennan and Franks (1997).

of Booth and Smith's (1986) certification hypothesis, which predicts that reputable intermediaries, such as investment bankers, auditors, or venture capitalists, can certify to investors that a given IPO is not overpriced. If empirical evidence shows that venture-backed IPOs are less underpriced than nonventure backed IPOs [Megginson and Weiss (1991)], can we infer that investors do in fact credit venture capitalists with certification power? Not necessarily, for it is possible that venture-backed IPOs happen to have a greater incentive to reduce underpricing, by means of their promotion choices, because their owners sold more equity.[12] As a consequence, we argue that empirical tests of IPO underpricing theories should be conditioned on the owners' incentives to take costly actions that reduce underpricing. Ignoring these incentives can lead to omitted variable bias, resulting in incorrect inferences being drawn from empirical work.

1. Model and Testable Implications

1.1 Outline of the model

We briefly outline the main features of our model before proceeding to its detailed analysis. Our model shares Rock's (1986) adverse selection rationale for underpricing. There are two types of investors. Informed investors know the quality of an issue and naturally subscribe only to "good" issues. Uninformed investors cannot distinguish between "good" and "bad" issues, and so suffer from the winner's curse: They are likely to be allocated a disproportionate share of "bad" issues, to which informed investors do not subscribe. To induce uninformed investors to take part in the offering, it is therefore necessary to sell the issue at a price below that warranted by its intrinsic quality. As the winner's curse increases in proportion to the fraction of informed investors with whom good issues are shared, so does the necessary amount of underpricing.

The fractions of informed and uninformed investors are exogenously fixed in Rock (1986), but in our model they can be endogenously determined by the issuer. Specifically, we assume that the issuer can increase the fraction of uninformed investors participating in the offering by incurring greater promotion costs. For example, the issuer can, at a cost, hire a more reputable underwriter, whose greater reputational capital will encourage more uninformed investors to take part in the offering.[13] Underpricing decreases as a result.

Though undoubtedly beneficial to the issuer, the decrease in underpricing requires the issuer to incur higher promotion costs. These may offset the benefit of lower underpricing. How the issuer chooses between underpricing and

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[12] Indeed, Table 3 in Megginson and Weiss (1991) suggests that venture-backed firms in the 1980s issued 36% more shares on average than did nonventure-backed firms.

[13] See Booth and Smith (1986), Carter and Manaster (1990), and Titman and Trueman (1986). For contrary evidence, see Beatty and Welch (1996). We return to this issue in Section 3.3.

promotion costs naturally depends on how a given combination of promotion costs and the associated underpricing affects wealth losses from going public. This in turn depends on the issuer's participation in and the dilution resulting from the offering.

1.2 The model

Consider an entrepreneur who wishes to sell part of a firm and/or to raise new capital through an IPO. The entrepreneur owns all N_o original shares of the firm. She sells $N_{o,s} \geq 0$ original (secondary) shares and retains $N_{o,r} = N_o - N_{o,s}$ shares. She issues and sells $N_n \geq 0$ new (primary) shares.

Let a share have value P_G and P_B with equal probability, with $P_G > P_B$. Prior to the IPO, expected share value is $\overline{P} = (P_G + P_B)/2$ with variance $\sigma^2 = \frac{1}{4}\Delta^2$, where $\Delta \equiv P_G - P_B$. Informed investors, who constitute a fraction β_I of the total population of investors, know the true value. Uninformed investors, who constitute a fraction $\beta_U = 1 - \beta_I$, and the entrepreneur do not.

As discussed in Section 1.1, the fractions β_I and β_U depend on the promotion costs incurred by the entrepreneur. Specifically, $\beta_U \equiv \beta_U(exp)$, where exp denotes the promotion cost per original share. We assume $\beta_U'(exp) > 0$ and $\beta_U''(exp) < 0$: higher promotion costs induce more uninformed investors to take part in the offering but at a decreasing rate.

As is the case in practice, we assume that a fraction α of total promotion costs $EXP \equiv N_o exp$ is paid by the firm and the remainder $1 - \alpha$ directly by the entrepreneur.[14] $\alpha = N_n/(N_n + N_{o,s}) = n_n/(n_n + n_{o,s})$, as the fraction of the costs paid by the firm is proportional to the firm's fraction of the proceeds from the IPO.[15] $n_{o,s} \equiv N_{o,s}/N_o$ is the number of secondary shares sold normalized by the total number of original shares, and $n_n \equiv N_n/N_o$ is the normalized number of primary shares. We refer to $n_{o,s}$ as the issuer's participation ratio and to n_n as the dilution factor. We use normalized variables because the absolute number of shares is arbitrary: There is evidence that issuers split their shares before an IPO to generate offer prices within certain ranges.[16]

The $N_{o,s}$ secondary shares and the N_n primary shares are sold at a price P_0. Following the IPO, the value of a share of the firm is $P_{1,G} = (N_o P_G + N_n P_0 - \alpha N_o exp)/(N_o + N_n)$ or $P_{1,B} = (N_o P_B + N_n P_0 - \alpha N_o exp)/(N_o + N_n)$ with equal probability. Post-IPO, a share therefore has price $\overline{P}_1 = 1/(1 + n_n)\overline{P} + n_n/(1 + n_n)P_0 - (\alpha \cdot exp)/(1 + n_n)$ and variance $\sigma_1^2 = 1/(1 + n_n)^2\sigma^2$.

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[14] Throughout, we will use lowercase letters to denote variables normalized by the number of original shares N_o and capitals to denote untransformed variables.

[15] Of course, the entrepreneur, as the firm's original owner, ultimately bears the entirety of the promotion costs *EXP*. But the distinction between the fraction of promotion costs that is paid directly by the entrepreneur and that paid indirectly through the entrepreneur's ownership of the firm has important implications for our comparative statics results, as Proposition 2 will show.

[16] The median offer price in the U.S. has been virtually unchanged at around $11 since the 1970s even though median gross proceeds have more than tripled, from $8 million the 1970s to $28 million in the early 1990s.

The price P_0 at which shares are sold to investors must be such that uninformed investors expect to break even on average, for they otherwise would not subscribe to the IPO. P_0 is therefore such that $\frac{1}{2}\beta_U(P_{1,G} - P_0) + \frac{1}{2}(P_{1,B} - P_0) = 0 \Longleftrightarrow P_0 = (\beta_U P_G + P_B)/(1 + \beta_U) - \alpha \cdot \exp < \overline{P}$, where the ultimate equality is true by substituting the values of $P_{1,G}$ and $P_{1,B}$ and the inequality is true by noting that $\beta_U < 1$. As noted by Rock (1986), shares must be sold at a discount to their expected pre-IPO value to compensate uninformed investors for the adverse selection introduced by the presence of informed investors.[17]

Shares are also sold at a discount to their expected post-IPO value, $\overline{P}_1$. This can be seen by substituting the expression for P_0 into that for $\overline{P}_1$ to obtain

$$\overline{P}_1 = \frac{1}{1+n_n}\overline{P} + \frac{n_n}{1+n_n}\frac{\beta_U P_G + P_B}{1 + \beta_U} - \alpha \cdot \exp$$
$$> \frac{\beta_U P_G + P_B}{1 + \beta_U} - \alpha \cdot \exp = P_0. \tag{1}$$

In common with the IPO literature, underpricing is defined as $UP \equiv (\overline{P}_1 - P_0)/P_0$. The normalized wealth loss suffered by the issuer due to such underpricing, the resulting dilution in the stake (because $\overline{P}_1 < \overline{P}$ as $P_0 < \overline{P}$) and the share of the promotion costs is

$$wl \equiv \frac{1}{N_o}\left(N_{o,r}(\overline{P} - \overline{P}_1) + N_{o,s}(\overline{P} - P_0) + (1 - \alpha)N_o \exp\right)$$
$$= \left(\frac{n_{o,s} + n_n}{1 + n_n}\right)\left(\overline{P} - \frac{\beta_U P_G + P_B}{1 + \beta_U}\right) + \exp. \tag{2}$$

Note that the issuer bears the entirety of the promotion cost *exp*.

1.3 Results and discussion

The purpose of our analysis is to examine the variation in the underpricing return UP and the wealth loss wl as a function of the participation ratio $n_{o,s}$, the dilution factor n_n, the uncertainty parameter Δ, and the promotion cost *exp*. The issuer minimizes wealth losses from going public. She therefore solves the optimization problem

$$\underset{exp}{\text{Min}}\ wl \Longleftrightarrow \underset{exp}{\text{Max}}\left(\frac{n_{o,s} + n_n}{1 + n_n}\right)\left(\frac{\beta_U P_G + P_B}{1 + \beta_U}\right) - \exp,$$

which has first-order condition

$$\left(\frac{n_{o,s} + n_n}{1 + n_n}\right)\frac{\Delta}{(1 + \beta_U)^2}\beta'_U(\exp) - 1 = 0. \tag{3}$$

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[17] Note the presence of the $\alpha \cdot$ *exp* term: The issue price is further decreased by the fraction of promotion costs that is paid by the firm.

The issuer's choice of *exp* clearly depends on $n_{o,s}$, n_n, and Δ. Indeed, we have:

Proposition 1. *The promotion cost of the IPO, exp, increases in the participation ratio $n_{o,s}$, the dilution factor n_n, and the uncertainty parameter Δ.*

Proof. Immediate from equation (3). ∎

The results for the participation ratio and the dilution factor confirm our informal discussion in the introduction and in Section 1.1: An issuer who sells a greater fraction of a firm or issues more new shares has a greater incentive to control wealth losses from underpricing. She does so by increasing promotion costs. She also increases promotion costs in response to greater uncertainty because, as we show in Proposition 2, underpricing and hence wealth losses increase in uncertainty.

We can now establish our main result.

Proposition 2. *The wealth loss wl increases in the participation ratio $n_{o,s}$, the dilution factor n_n, and the uncertainty parameter Δ. It is invariant to the promotion cost exp in equilibrium. The underpricing return UP decreases in the promotion cost exp and in the participation ratio $n_{o,s}$. Its variation in the dilution factor n_n is indeterminate. It increases in the uncertainty parameter Δ when controlling for the promotion cost exp, but its variation in Δ is otherwise indeterminate.*

Proof. See Appendix. ∎

The results for the variation of the wealth loss in the participation ratio, the dilution factor, and the uncertainty parameter are similar to and share the same intuition as those for the promotion cost in Proposition 1. The invariance of the wealth loss to the promotion cost in equilibrium is nothing but the reflection of the zero first-order condition at the optimum. Recall that the first premise of our analysis implies that the issuer chooses promotion costs to minimize wealth loss from going public.

That underpricing decreases in the promotion cost confirms the second premise. The issuer can affect underpricing through the choice of promotion cost. The decrease of underpricing in the participation ratio combines this inverse relation between underpricing and promotion costs with the proportional relation between the promotion cost of the IPO and the participation ratio established in Proposition 1.

That underpricing does not necessarily decrease in the dilution factor, despite the similarity between the dilution factor and the participation ratio, is a consequence of the offsetting effect of the dilution factor on underpricing through the fraction α of the promotion cost that is paid by the issuer. As can be seen from inequality (1), both the issue price and the post-IPO price decrease in α, by the same amount $\alpha \cdot exp$. This identical absolute effect

translates into a greater relative effect on the issue price, which is smaller than the post-IPO price. This increases underpricing.

The proportional relation between underpricing and uncertainty is a well-known result. As in Beatty and Ritter (1986), uncertainty increases the extent of the adverse selection problem faced by uninformed investors. They consequently require a greater discount to be induced to take part in the offering. However, this argument assumes promotion costs are fixed. It does not recognize the issuer's incentive to increase these costs for the purpose of countering the increase in the discount granted uninformed investors. Extending the argument to incorporate the issuer's incentive to increase promotion costs reveals two distinct effects of uncertainty on underpricing: a direct effect, which increases underpricing, and an indirect effect through promotion costs. The variation of underpricing in the combination of these two effects is indeterminate, for the direct effect increases underpricing whereas the indirect effect decreases it.

1.4 Empirical implications

From the results of Section 1.3, we can write our empirical implications as follows:

1. Wealth losses increase in the participation ratio, the dilution factor, and uncertainty. They are invariant to promotion costs in equilibrium.
2. Promotion costs increase in the participation ratio, the dilution factor, and uncertainty.
3. Underpricing decreases in promotion costs and in the participation ratio. It is indeterminate in the dilution factor. It increases in uncertainty when controlling for promotion costs, but is indeterminate otherwise.

The intuition behind these empirical implications is as in Section 1.3. For a given level of underpricing, wealth losses increase in the number of primary and secondary shares sold. Wealth losses increase in uncertainty because the direct effect of uncertainty is to increase underpricing, which increases wealth losses. Promotion costs are chosen to minimize wealth losses. In equilibrium, wealth losses are therefore invariant to promotion costs.

Promotion costs increase in the participation ratio, the dilution factor, and uncertainty because wealth losses increase in these three variables. The issuer counters the increased wealth losses by increasing promotion costs.

Underpricing decreases in promotion costs because promotion costs increase the fraction of uninformed investors participating in the offering. Underpricing decreases in the participation ratio because underpricing decreases in promotion costs and promotion costs increase in the participation ratio. A similar effect for the dilution factor is countered by the increase in the fraction of promotion costs paid by the firm. For a given level of

promotion costs, underpricing increases in uncertainty, but the increase in promotion costs brought about by increased uncertainty counters that first effect.

Recalling that *exp*, *UP*, *wl*, $n_{o,s}$, n_n, and Δ denote promotion costs, underpricing, wealth losses, the participation ratio, the dilution factor, and uncertainty, respectively, we can write the regression equations corresponding to the preceding empirical implications as

$$exp = \gamma_0 + \overset{+}{\gamma_1}\, n_{o,s} + \overset{+}{\gamma_2}\, n_n + \overset{+}{\gamma_3}\, \Delta + \varepsilon \tag{exp1}$$

$$UP = \delta_0 + \overset{-}{\delta_1}\, n_{o,s} + \overset{?}{\delta_2}\, n_n + \overset{+}{\delta_3}\, \Delta + \overset{-}{\delta_4}\, exp + \zeta \tag{UP1}$$

$$= (\delta_0 + \delta_4 \cdot \gamma_0) + (\overset{-}{\delta_1} + \overset{-}{\delta_4} \cdot \overset{+}{\gamma_1})n_{o,s} + (\overset{?}{\delta_2} + \overset{-}{\delta_4} \cdot \overset{+}{\gamma_2})n_n$$

$$+ (\overset{+}{\delta_3} + \overset{-}{\delta_4} \cdot \overset{+}{\gamma_3})\Delta + \delta_4\varepsilon + \zeta$$

$$\equiv \pi_0 + \overset{-}{\pi_1}\, n_{o,s} + \overset{?}{\pi_2}\, n_n + \overset{?}{\pi_3}\, \Delta + v \tag{UP2}$$

and

$$wl = \varphi_0 + \overset{+}{\varphi_1}\, n_{o,s} + \overset{+}{\varphi_2}\, n_n + \overset{+}{\varphi_3}\, \Delta + \overset{0}{\varphi_4}\, exp + \eta, \tag{wl1}$$

where ε, ζ, v, and η are error terms. The signs of the coefficients are as predicted in Propositions 1 and 2 and points 1 to 3 above. Note that the slope coefficient φ_4, which measures the marginal effect of promotion costs on wealth losses, is zero by virtue of the first-order condition for optimality.

There are two nested underpricing equations. Regression (UP2) is obtained from regression (UP1) by substituting regression (exp1) for *exp*. The two regressions differ in that the slope coefficients of (UP1) constitute partial derivatives, whereas those of (UP2) are total derivatives, which incorporate both the direct effect of the participation ratio, the dilution factor, and uncertainty on underpricing, and their indirect effect through the promotion cost *exp*. This combination of direct and indirect effects gives rise to the following cross-equation restrictions:

$$H_{0,\,R1a} : \pi_1 \equiv \overset{-}{\delta_1} + \overset{-}{\delta_4}\,\overset{+}{\gamma_1} \Longrightarrow \pi_1 < \delta_1$$

$$H_{0,\,R1b} : \pi_2 \equiv \overset{?}{\delta_2} + \overset{-}{\delta_4}\,\overset{+}{\gamma_2} \Longrightarrow \pi_2 < \delta_2 \tag{R1}$$

$$H_{0,\,R1c} : \pi_3 \equiv \overset{+}{\delta_3} + \overset{-}{\delta_4}\,\overset{+}{\gamma_3} \Longrightarrow \pi_3 < \delta_3.$$

The intuition is clear. The indirect effect through *exp* unambiguously decreases underpricing. The slope coefficients that combine both effects should therefore be algebraically smaller than the slope coefficients that include the direct effect alone.

Before we can estimate our regressions, we need to be careful about which variables we treat as exogenous. Clearly, *UP* and *wl* each depend on *exp*, and all three variables depend on $n_{o,s}$, n_n, and Δ. In our empirical work, we

will therefore treat *exp*, *UP*, and *wl* as endogenous and $n_{o,s}$, n_n, and Δ as exogenous. We first outline how we deal with endogeneity and then discuss how we test our exogeneity assumption. The usual way to deal with the joint endogeneity of *exp*, *UP*, and *wl* is to use two-stage least squares (2SLS) or generalized method of moments (GMM). However, the two systems of equations (exp1) and (UP1), and (exp1) and (wl1), each form what is called a fully recursive triangular system. Such systems can be written as

$$y_1 = x'\lambda_1 + \epsilon_1$$
$$y_2 = x'\lambda_2 + \mu_{12}y_1 + \epsilon_2.$$

In our model, y_1 equals *exp*; the vector x consists of $n_{o,s}$, n_n, and Δ; and y_2 equals *UP* when considering regression (UP1) and *wl* when considering regression (wl1). Regression (UP2) can be viewed as the reduced form of regression (UP1).

By repeated substitution, it can easily be shown that triangular systems can be consistently estimated using equation-by-equation ordinary least squares (OLS), as long as the errors are uncorrelated across regressions [see Greene (1997, p. 736f), the proof is in Hausman (1978)]. We test and fail to reject this restriction in Section 3.1. This confirms the validity of the triangular form assumed, suggests there are no omitted variables common to the regressions, and justifies our use of equation-by-equation OLS. In a previous version of the article, we also reported 2SLS and GMM estimates that were statistically identical to the OLS estimates reported below.

Our model does not endogenize the decision of how many shares to float, so we treat $n_{o,s}$ and n_n as exogenous. This is not to claim that issuers do not choose the offer size, merely that the determinants of offer size are uncorrelated with our variables of interest. If true, it allows us to look at the choice of promotion strategies and wealth loss minimization *conditional on the issuer's choice of offer size*. If not true, our empirical model will be misspecified and our coefficient estimates biased. There are plausible reasons to suppose that offer size may be correlated with our variables of interest. For instance, issuers might use offer size alongside underpricing to signal inside information, as in the signaling models of Allen and Faulhaber (1989), Grinblatt and Hwang (1989), and Welch (1989). Alternatively, issuers might adjust offer size in the light of information gathered during book-building.[18] We show in Section 3.2 that our decision to treat the size of the offer as exogenous can be justified by means of a Hausman (1978) specification test.

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[18] We thank Sheridan Titman for suggesting this alternative explanation.

2. The Data

2.1 Data sources

Our empirical work uses a sample of U.S. IPOs floated on NASDAQ between 1991 and 1995.[19] Securities Data Company's (SDC) New Issues database lists 1409 NASDAQ IPOs during that period, excluding companies issuing American depository receipts or noncommon shares, real-estate and other investment trusts, and unit offerings. We lost 30 companies for which data on $N_{o,s}$, N_o, N_n, or promotion costs *exp* was unavailable and excluded 3 companies that increased their capital at the IPO more than 100-fold.[20] The final sample consists of 1376 companies.

Most cross-sectional data is taken from SDC's database. First-day trading prices come from the Center for Research in Security Prices (CRSP) tapes. Information on overallotment option exercise was gathered from Standard & Poor's *Register of Corporations*, news sources, and subsequent 10-Qs and 10-Ks because we find, as do Ellis, et al. (2000), that SDC's exercise information is reported with error. Information about company age at flotation comes from S&P's *Register*. To measure underwriter quality, we use the "tombstone" underwriter reputation rank variable developed by Carter and Manaster (1990), as updated for the 1990s by Carter, et al. (1998).

2.2 Variable definitions and model specifications

The three dependent variables in our model are the underpricing return, estimated from the IPO price to the first-day closing price; wl = wealth losses per old share, as calculated in Equation (2); and exp = normalized promotion costs, taken from the SDC's New Issues database. *exp* includes auditing, legal, road show, exchange, printing, and other expenses of the offering as well as accountable and nonaccountable underwriter expenses, but not the underwriter spread, which we view as a payment for underwriting risk and thus not a choice variable.

The specification of most of our regressors, such as the participation ratio and the dilution factor, is determined by our theoretical model. To control for ex ante uncertainty Δ, we use two alternative types of proxies. The first type is firm characteristics, specifically company age at flotation, the natural log of sales as a measure of firm size, and preflotation leverage ($= debt/[debt + equity]$) as reported by SDC. Prior studies suggest that younger and smaller companies are riskier and thus more underpriced [Ritter (1984, 1991), Megginson and Weiss (1991)], whereas the presence of credit

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[19] In a previous draft, we also used Ritter's (1991) sample covering IPOs from 1975 to 1984. Both samples yield similar results.

[20] Their dilution factors ranged from a 575-fold to a 4025-fold increase in shares outstanding. Ratios that high are invariably due to very low reported preflotation N_o and could conceivably be due to data errors. We tried—unsuccessfully—to verify this by means of a Nexis news search. The exclusion is clearly ad hoc, but we note that it in fact *weakens* our empirical results.

relationships reduces uncertainty and required underpricing [James and Wier (1990)].[21]

The second type of proxy is derived from the put option nature of the underwriting contract. James (1992, p. 1876) argues, "The greater the uncertainty concerning firm value, the greater the risk borne by underwriters in a firm commitment offer. Therefore, a positive relation is expected between [gross] spreads and measures of uncertainty." There is ample empirical support for James's hypothesis that spreads and uncertainty are positively related; see James (1992) on IPOs, Stoll (1976), Booth and Smith (1986), and Gande, et al. (1999) on seasoned equity offerings; Dyl and Joehnk (1976) on underwritten corporate bond issues; and Sorensen (1980) on municipal bonds. It seems likely that underwriters are better placed to estimate ex ante uncertainty than an investor who merely observes company age, size, and the existence of credit relationships. We thus expect spreads to be incrementally informative about valuation uncertainty.

Information about gross spreads is readily available in SDC's database. However, instead of the gross spread we use only one of its components, the so-called underwriting fee. There are two reasons for this. First, the gross spread compensates the investment bank for more than its underwriting services. A narrower proxy, the underwriting fee charged for the underwriting cover, should hence be more informative about valuation uncertainty. Second, Chen and Ritter (2000) document a tendency for gross spreads to be exactly 7% for over 90% of medium-sized IPOs in the mid-to late 1990s. Through this tendency is less pronounced in our (earlier) sample period, it still affects 60% of sample firms. Underwriting fees, on the other hand, are much less prone to clustering.[22]

We also control for the partial-adjustment phenomenon first documented by Hanley (1993), consistent with Benveniste and Spindt's (1989) prediction that expected underpricing, in a world of asymmetric information, is minimized when discounts are concentrated in states where investors provide strong indications of interest during the bank's promotion effort. Following Hanley, we control for investor interest by including a variable *partadj*, which equals the percentage adjustment between the midpoint of the indicative price range and the offer price. Finally, we control for the possibility of "hot" or "cold" IPO markets [Ritter (1984), Ibbotson et al.(1994)] by including time dummies.

2.3 Descriptive statistics

Table 1 reports descriptive statistics on company (panel A) and offering (panel B) characteristics and the associated costs and wealth losses (panel C).

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[21] Another popular proxy is offer size. We refrain from using it because Habib and Ljungqvist (1998) show that as a matter of identities, underpricing is strictly decreasing in offer size *even when holding risk constant*.

[22] Specifically, in our sample they are four times more variable than gross spreads.

Table 1
Descriptive sample statistics

Variable description	Mean	Standard deviation	Median
Panel A: Company characteristics			
Age at IPO	14.2	19.7	8.0
Sales, in millions of $	79.9	190.3	34.1
Leverage, in %	17.4	23.6	5.7
Panel B: Offering characteristics			
Nominal gross proceeds, in millions of $	36.8	37.9	28.5
Preflotation number of shares	6,636,717	6,825,628	4,986,314
Number of secondary shares sold	424,407	908,219	0
Number of primary shares sold	2,505,365	1,966,985	2,150,000
Participation ratio, in %	7.0	11.9	0.0
Dilution factor, in %	50.1	46.7	42.4
Underwriting fee, in % of offer price	1.69	0.61	1.57
Carter-Manaster underwriter reputation rank	7.26	2.57	8.75
Partial adjustment, in %	0.19	20.08	0.00
Underpricing return, in %	13.8	20.3	7.1
Panel C: Promotion costs and wealth losses			
Wealth losses, in $	6,541,695	12,629,193	2,400,483
of which: promotion costs, in $	*739,000*	*486,872*	*650,000*
Wealth loss per old share, in cents	106.7	154.8	54.2
of which: promotion costs per old share, in cents	*16.6*	*15.6*	*13.0*

The sample covers the 1376 firms floated on NASDAQ between 1991 and 1995. All $ amounts are in nominal terms. Panel A tabulates three company characteristics. Age is IPO year less founding year, taken from S&P's C*orporate Register* and is available for 1357 of the 1376 firms. Sales is annual net sales in the fiscal year prior to the IPO. Leverage is debt over debt plus equity. Panel B tabulates various offering characteristics. Nominal gross proceeds is $P_0(N_n + N_{o,s})$, where P_0 is the offer price and $(N_n + N_{o,s})$ is the sum of primary (new) and secondary (old) shares offered. The participation ratio $n_{o,s}$ is $N_{o,s}/N_o$, that is, the fraction of preflotation shares N_o sold in the IPO. The dilution factor is $n_n = N_n/N_o$. We excluded three firms from the data set for having dilution factors in excess of 10,000%; their inclusion would have strengthened our results. The underwriting fee is that component of the gross spread which represents compensation to the syndicate for providing underwriting cover. The Carter-Manaster (1990) ranks measure underwriter reputation on a scale from 0 (lowest) to 9 (highest). We use the updated ranks provided by Carter et al. (1998). Partial adjustment equals the percentage adjustment between the midpoint of the indicative price range and the offer price. Underpricing is $\bar{P}_1/P_0 - 1$, where $\bar{P}_1$ is the closing share price on the first day of trading, extracted from the daily CRSP tapes. Panel C computes marketing costs and wealth losses. The wealth loss per old share is *wl* in Equation (2), that is, the sum of wealth losses due to dilution, underpricing, and marketing costs per old share *exp*. Wealth losses are reported both in absolute terms and normalized by N_o. Promotion costs *exp* are taken from the SDC's New Issue database and include auditing, legal, road show, exchange, printing, and other expenses of the offering as well as accountable and nonaccountable underwriter expenses, but not the underwriter spread.

As in prior studies, the median issuer in panel A is a young company (8 years) with modest sales ($34.1 million) and little debt (5.7% leverage). The averages in each case are higher, indicating positive skewness. The median (average) amount raised in Panel B is $28.5 million ($36.8 million). Much of this represents a capital increase: On average, the original owners sell only 7% of their shares ($n_{o,s}$) while increasing shares outstanding by 50% (n_n). Purely secondary offerings are extremely rare, accounting for only 11 of the 1376 IPOs. Purely primary offerings, around half the sample, are much more common. The remainder combine primary and secondary offerings. The average gross spread (not shown) is 7.149% of the offer price, with a median of 7%. The component of the gross spread that we are interested in, the underwriting fee, averages 1.7%. The quality ranking of lead underwriters is extremely

high, averaging 7.26 on Carter and Manaster's 0–9 scale.[23] The median of 8.75 is even higher. For comparison, the average and median rank in Ritter's (1991) sample of 1526 IPOs floated in 1975–1984 is only 6. Both the median and the average company go public at a price equal to the midpoint of the filing range, which might thus be interpreted as an unbiased estimate of the offer price. Nonetheless, there is considerable learning: 25% of sample firms are priced below the low filing price, and 23% are priced above the high filing price. Underpricing averages 13.8% in our sample, in line with previous studies. 9.5% of sample firms close strictly below the offer price, and 16.4% close exactly at the offer price. The remaining 74.1% are underpriced.

Wealth losses for the median issuer in panel C are $2.4 million, which include promotion costs of $650,000. Average wealth losses are higher, at $6.5 million, due to the presence of some highly underpriced offerings. On a per-share basis, the average (median) wealth loss is 107 ¢(54 ¢), 17 ¢(13 ¢) of which represents promotion expenses. The remainder is due to the effects of selling underpriced shares and suffering dilution on retained shares.

3. Empirical Results

3.1 Regression results

Table 2 presents the equation-by-equation least-squares results for the four regressions (exp1), (UP1), (UP2), and (wl1), adjusted for heteroscedasticity using White's (1980) heteroskedasticity-consistent covariance matrix. The first column estimates the determinants of promotion costs *exp*. The *exp* regression exhibits considerable explanatory power with an adjusted R^2 of 58%. The coefficients estimated for $n_{o,s}$ and n_n are positive and statistically significant at the 0.1% level and confirm our prediction that issuers spend more on promotion, the greater their participation ratio and dilution factor. We also include gross proceeds to control for economies of scale in promotion costs [see Ritter (1987)] and find significant support for the expected negative relationship between gross proceeds and promotion costs per share. *Underwriting fees* correlate positively with promotion costs, consistent with the hypothesis that greater valuation uncertainty increases *fees*, though the coefficient is significant only at the 7% level. The other risk proxies, *age*, *log sales*, and *leverage*, perform less well. To assess the economic significance, we consider the effect of two-quartile changes in the independent variables (from the first to the third quartile) on the left-hand-side variable. The regressor with the greatest economic effect is n_n. A two-quartile change in n_n increases promotion costs *exp* from 11.6 ¢ to 19 ¢ a share, and a two-quartile change in $n_{o,s}$ increases *exp* from 15.5 ¢ to 17.2 ¢ and a similar change in gross proceeds cuts *exp* from 18.4 ¢ to 16 ¢, all else equal.

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[23] 182 of our sample firms use underwriters that are not ranked in Carter and Manaster (1990) or Carter et al. (1998). We inspect the banks they use, only one of which (J. P. Morgan) strikes us as obviously prestigious. We arbitrarily assign it a rank of 8. The remaining banks are assigned a rank of 0. Our results are robust to different treatments.

Table 2
Ordinary least squares regressions of promotion costs, underpricing, and wealth losses

		Promotion costs *exp*	Underpricing		Wealth losses *wl*
		(expl)	(UP1)	(UP2)	(wll)
Constant		0.042**	0.187***	0.186***	0.877***
		0.016	0.025	0.025	0.255
$n_{o,s}$	γ_1	0.153*** δ_1	−0.055* π_1	−0.071* φ_1	1.367**
		0.020	0.028	0.028	0.444
n_n	γ_2	0.252*** δ_2	0.007 π_2	−0.023* φ_2	0.847†
		0.020	0.011	0.009	0.446
exp		δ_4	−0.125***	φ_4	0.023
			0.033		0.451
gross proceeds		−0.001***			
		0.000			
partadj			0.509***	0.511***	3.501***
			0.040	0.040	0.285
Risk proxies	γ_3	δ_3	π_3		φ_3
underwriting fee		0.009†	0.031**	0.029*	0.115
		0.005	0.011	0.011	0.095
age		−0.0001	−0.0004*	−0.0004*	−0.004**
		0.0001	0.0002	0.0002	0.002
ln(*sales*)		0.005*	−0.007*	−0.007*	−0.042
		0.002	0.004	0.004	0.026
leverage		0.0004	−0.068**	−0.068**	−0.421*
		0.013	0.021	0.021	0.169
Diagnostics					
Adjusted R^2		57.9%	33.2%	32.8%	31.4%
F-statistic		26.61***	25.69***	27.91***	23.95***
Wald test of restrictions			$F = 0.01 (p = 99.8\%)$		
Correlation of residuals			−0.006		0.024
Hausman specification test		$\chi^2 = 23.76\ (p = 9.5\%)$			
Observations		1357	1357	1357	1357

We estimate the following four regressions via equation-by-equation ordinary least-squares:

$$exp_i = \gamma_0 + \gamma_1 n_{o,si} + \gamma_2 n_{ni} + \gamma_3 \Delta_i + \gamma_4\ gross\ proceeds_i + \varepsilon_i \quad \text{(exp1)}$$
$$UP_i = \delta_0 + \delta_1 n_{o,si} + \delta_2 n_{ni} + \delta_3 \Delta_i + \delta_4 exp_i + \delta_5\ partadj_i + \zeta_i \quad \text{(UP1)}$$
$$UP_i = \pi_0 + \pi_1 n_{o,si} + \pi_2 n_{ni} + \pi_3 \Delta_i + \pi_5\ partadj_i + v_i \quad \text{(UP2)}$$
$$wl_i = \varphi_0 + \varphi_1 n_{o,si} + \varphi_2 n_{ni} + \varphi_3 \Delta_i + \varphi_4 exp_i + \varphi_5\ partadj_i + \eta_i \quad \text{(wll)}$$

Variables are as defined in Table 1. Underpricing is $\overline{P}_1/P_0 - 1$. *gross proceeds* is in \$m. *partadj* is the adjustment between the midpoint of the indicative price range and the offer price. As proxies for ex ante uncertainty about firm value, Δ, we use the underwriting fee, company age at flotation, log sales, and leverage. The γ_i, δ_i, π_i, and φ_i refer to the regression parameters identified in Section 2. Note that $H_0: \varphi_4 = 0$ tests for optimality. Standard errors, given in italics under the coefficient estimates, are adjusted for heteroscedasticity using White's (1980) heteroscedasticity-consistent covariance matrix. One, two, and three asterisks indicate significance at the 5%, 1%, and 0.1% level or better, respectively, and †indicates significance at 10%. The *F*-test tests the hypothesis that all parameter estimates are jointly zero. The Wald test of restrictions refers to the cross-equation restrictions linking γ_i, δ_i, and π_i. "Correlation of residuals" correlates the residuals of (exp1) and (UP1) and of (exp1) and (wl1). Equation-by-equation least squares is only consistent if these correlations are zero. The Hausman specification test tests for the exogeneity of offer size with respect to underpricing. All regressions include year dummies (coefficients not shown). Results are robust to outliers when estimating the four regressions across quartiles of $n_{o,s}$ and n_n. The sample size is reduced to 1357 due to missing information on company age.

The second column reports the coefficients estimated for regression (UP1). By the standards of the IPO literature, the regression has very high explanatory power, with an adjusted R^2 of 33%. The estimated coefficients strongly support our predictions: Underpricing is lower the larger the participation ratio $n_{o,s}$ ($p = 4.5\%$) and the more issuers spend on promotion ($p < 0.01\%$). A two-quartile increase in promotion costs *exp* lowers underpricing by 142

basis points to 13.4%. A similar increase in $n_{o,s}$ lowers underpricing by 60 basis points to 13.6%. These effects obtain after controlling for Hanley's (1993) partial adjustment effect, whose existence we confirm in our data set: Underpricing is significantly greater the more the offer price exceeds the midpoint of the filing range. The findings are also robust to controlling for valuation uncertainty using either set of proxies: Younger and smaller issuers and issuers with higher put option premia (*underwriting fee*) are significantly more underpriced, and the presence and extent of prior credit relationships (*leverage*) significantly reduce underpricing as in James and Wier (1990).

Regression (UP2) in the third column drops *exp* from the underpricing equation, forcing the effect of promotional activities on underpricing into the coefficients for $n_{o,s}$, n_n and valuation uncertainty. Adjusted R^2 drops slightly, to 32.8%, and the remaining coefficients appear negatively biased compared to regression (UP1). Our cross-equation restrictions (R1) predict that the size of the bias is exactly $-\delta_4 \gamma_i$, using the notation of Section 1.4. Wald tests on the coefficients reported for regressions (UP1) and (UP2) in Table 2 fail to reject these restrictions at any level of significance. Proposition 2 predicts that underpricing decreases in $n_{o,s}$—which the negative and statistically significant coefficient confirms—but leaves the remaining effects unsigned. Still, the coefficients estimated for the remaining effects are intuitive: Higher dilution n_n leads to lower underpricing ($p = 1.2\%$) and greater valuation uncertainty leads to higher underpricing ($p = 4.8\%$ or better, depending on the proxy).

The final column of Table 2 investigates the determinants of wealth losses. As predicted in Proposition 2, wealth losses increase significantly in $n_{o,s}$ ($p = 0.2\%$) and n_n ($p = 5.7\%$) as well as valuation uncertainty, all of which confirms the comparative statics of our model—comfortably so in view of the high adjusted R^2 of 31.4%. Furthermore, issuers seem to be choosing their promotion spending *optimally*: The coefficient of 0.023 estimated for *exp* is virtually zero, as predicted in Proposition 2. Note that the dependent variable here is total wealth losses, including promotion costs. If we regress wealth losses *excluding* promotion costs on the same set of variables, we find that every dollar of promotion spending reduces wealth losses by 98 ¢, which clearly indicates that the marginal cost of promotion equals the marginal benefit, the reduction in wealth losses.[24]

As argued previously, OLS estimates will be consistent and efficient as long as the errors of the *exp* regression are uncorrelated with the errors of the underpricing and wealth loss regressions, respectively. Are they? Using the regression residuals, we cannot reject that the errors are indeed uncorrelated across equations, at any significance level, so the equation-by-equation least-squares results presented in Table 2 should be both consistent and efficient.

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[24] This follows immediately by subtracting *exp* from both sides of regression (wl1) in Table 2, giving a coefficient of $(0.023 - 1) = -.977$ for *exp*.

In summary, the signs and significance levels of the coefficients we estimate as well as the test of the cross-equation restrictions support each of our predictions, including the optimality condition.[25]

3.2 Exogeneity and feedback

Our empirical modeling has treated the number of shares sold as exogenous with respect to underpricing, ruling out a signaling role for underpricing or a feedback effect of underpricing on the choice of number of shares sold. To see whether the number of shares sold is indeed exogenous, we perform two tests. The first specifically addresses the possibility of feedback. Assume that during the course of book-building, the issuer learns that underpricing is likely to be high, perhaps because the expected winner's curse is high. A rational response for an issuer that does not face capital constraints is to reduce the size of the offering. Our empirical finding that smaller offerings are more underpriced could thus be due to feedback and learning during book-building, rather than promotion and incentives. To see if this is the case, we reestimate our four regressions (exp1), (UP1), (UP2), and (wl1) with the *intended* rather than actual number of shares sold.[26] Our results remain unchanged: Issuers spend more on promotion, the more shares they *intend* to sell, underpricing decreases in promotion costs and the intended number of shares to be sold, and expected wealth losses are invariant to promotion costs at the margin.

The second test is a Hausman (1978) specification test [see Greene (1997, p. 763)]. Assume that the number of shares sold is chosen simultaneously with underpricing (as in IPO signaling models) or that expected underpricing affects the number of shares sold (as in the feedback argument). In that case, the least-squares estimates of the effect of the number of shares sold on underpricing reported in Table 2 will be biased and inconsistent, and two- or three-stage least squares estimates will be consistent. If, on the other hand, the number of shares sold is exogenous with respect to underpricing (as our model assumes), all three estimation techniques will be consistent but only OLS will be efficient (because OLS is the best linear unbiased estimator, or BLUE). Hausman's test statistic measures the bias in the vector of coefficients under these alternative estimation techniques. In our case, we cannot reject the hypothesis that the bias is zero at the 10% level or better. This indicates that allowing the number of shares sold to be affected by underpricing does not significantly alter the least-squares coefficient estimates in Table 2.

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[25] We have repeated our tests using the absolute number of shares $N_{o,s}$ and N_n as well as the corresponding dollar amounts $N_{o,s} P_0$ and $N_n P_0$ in place of the normalized number of shares $n_{o,s}$ and n_n. The results, in either case, are qualitatively unchanged.

[26] SDC's New Issues database reports the intended number of shares as filed with the Securities and Exchange Commission. Unfortunately, it does not distinguish between primary and secondary shares, so we use $(N_{o,s} + N_n)_{intended}$, normalized by N_o.

3.3 Choice of underwriters

One of the promotion choices issuers can make is to hire prestigious underwriters who according to Titman and Trueman's (1986) model and Carter and Manaster's (1990) empirical evidence use their reputation capital to reduce underpricing. In the context of our model, we would expect (i) issuers' choice of underwriter prestige to depend on $n_{o,s}$ and n_n assuming that (ii) underpricing is indeed negatively related to underwriter reputation, such that (iii) issuers optimize at the margin, their wealth losses being invariant to changes in choice of underwriter. To test these predictions, we use the Carter-Manaster tombstone reputation variable, *rank*.

The results are in Table 3. The first two columns add *rank* to the underpricing and wealth loss regressions, (UP1) and (wl1), from Table 2. The OLS coefficients estimated for *rank* are positive and significant at $p < 1\%$, which leads to the surprising conclusion that more prestigious underwriters are associated with higher underpricing (and wealth losses). To illustrate, the estimated coefficient suggests that every unit increase in underwriter reputation *rank* (say from Volpe & Covington's 5 to First Albany's 6) increases underpricing by half a percentage point (say from 12.7% to 13.2%). In dollars, this would raise wealth losses by 5 ¢ a share, or $365,000 in total. The positive effect of bank reputation on underpricing is clearly at odds with evidence from the 1970s and 1980s but mirrors the results of Beatty and Welch (1996) and several recent articles that use 1990s data. However, these coefficient estimates tell only half the story. The regressions ignore that the choice of underwriter may be endogenous, which would result in biased OLS coefficients: According to our model, it should be the issuers with the most to gain from lower underpricing who choose the most prestigious underwriters.

Do they? The third column reports the results of estimating a probit regression of underwriter choice on $n_{o,s}$ and n_n, as well as promotion costs *exp* to control for substitution effects between underwriter prestige and other promotional activities, ln(*assets*) to control for Beatty and Welch's (1996) finding that larger firms use higher-quality underwriters, and the earnings per share for the last 12 months preflotation as reported in the prospectus.[27] The dependent variable is a dummy equaling 1 if the Carter-Manaster *rank* ≥ 7 [Carter et al's (1998) definition of prestigious banks] and 0 otherwise. The table reports the marginal effects of the independent variables on the probability of hiring a prestigious lead manager, evaluated at the means of the independent variables. Standard errors are heteroscedasticity-consistent.

The results clearly support the prediction that underwriter choice depends on firm and offering characteristics. The marginal effects estimated for $n_{o,s}$ and n_n are positive and significant and indicate that for every 10% increase in the participation ratio or dilution factor, the probability of hiring a prestigious

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[27] We include *EPS*, a variable we have not hitherto used, to allow instrumentation in what follows.

Table 3
Choice of underwriter

Estimation method	OLS		Probit		2SLS	
Dep. var	UP	wl	$rank \geq 7$	rank	UP	wl
Constant	0.144	0.440	$-0.319^{\dagger}$	5.857***	0.268***	0.965
	0.028	0.300	0.166	0.237	0.084	0.700
$n_{o,s}$	−0.058*	1.340**	0.328*	1.959**	$-0.050^{\dagger}$	1.372***
	0.028	0.446	0.167	0.552	0.029	0.445
n_n	0.004	$0.815^{\dagger}$	$0.083^{\dagger}$	0.555**	0.013	$0.854^{\dagger}$
	0.011	0.446	0.047	0.203	0.013	0.450
exp	−0.106***	0.218	−0.547***	−4.001***	−0.162***	−0.017
	0.033	0.440	0.153	0.607	0.047	0.546
underwriter rank	0.005**	0.049***			−0.009	−0.010
	0.002	0.012			0.009	0.075
partadj	0.506***	3.472***			0.515***	3.507***
	0.040	0.283			0.040	0.281
Risk proxies						
underwriting fee	0.038***	$0.182^{\dagger}$			0.019	0.101
	0.012	0.099			0.016	0.134
age	−0.0004*	−0.004**			−0.0004*	−0.004**
	0.0002	0.002			0.0002	0.002
ln(sales)	−0.009*	−0.059*			−0.004	−0.038
	0.004	0.027			0.005	0.040
leverage	−0.064**	−0.388*			−0.074***	−0.428*
	0.021	0.168			0.023	0.187
ln(assets)			0.110***	0.549***		
			0.012	0.054		
EPS_{-12}			−0.050*	−0.175***		
			0.023	0.053		
Diagnostics						
Adjusted R^2 (pseudo for Probit)	33.4%	31.9%	12.2%	12.7%	31.7%	31.8%
F-statistic (χ^2 for Probit)	24.30***	32.51***	114.46***	24.43***	51.15***	48.47***
Observations	1357	1357	1357	1357	1357	1357

We investigate the effect of underwriter reputation on underpricing and wealth losses under two alternative assumptions: that underwriter choice is exogenous (first two columns) and that it is endogenous to firm and offering characteristics (the remaining four columns). Underwriter reputation *rank* is measured using the lead manager's Carter-Manaster ranking. The first two columns add *rank* to regressions (UP1) and (wl1) from Table 2. The third column reports the results of a Probit where the dependent variable is a dummy equal to 1 if $rank \geq 7$, and 0 otherwise. The fourth column repeats this using as dependent variable *rank* itself. To allow identification in the 2SLS regressions in the final three columns, we include in the *rank* regressions two new independent variables, ln(*assets*), the log of assets, and EPS_{-12}, the earnings per share in the 12 months before the IPO. The final two regressions reestimate (UP1) and (wl1) allowing *rank* to be endogenously chosen in the first-stage *rank* regression. Standard errors, given in italics under the coefficient estimates, are adjusted for heteroscedasticity using White's (1980) heteroscedasticity-consistent covariance matrix. One, two, and three asterisks indicate significance at the 5%, 1%, and 0.1% level or better, respectively, and † indicates significance at 10%. The F-test tests the hypothesis that all parameter estimates are jointly zero.

lead manager increases by 3.3% and 0.8%, respectively.[28] Given the strongly negative marginal effect estimated for *exp*, prestigious underwriters and other promotional activities appear to be substitutes. The positive marginal effect of ln(*assets*) confirms Beatty and Welch's (1996) earlier observation. Finally, there is a significantly negative association between profitability and underwriter prestige, indicating that top banks are *more* likely to lead-manage

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[28] The results are somewhat sensitive to what cut-off point we choose and cease to be significant (but remain positive) if high reputation is defined as a rank of 8 or higher instead. Therefore, we also estimated an ordered multinomial logit with three categories (below 7, 7 to 8, above 8), which confirmed our results: Higher $n_{o,s}$ or n_n incrementally increase the likelihood of choosing an underwriter in the next highest category.

speculative IPOs. This is consistent with the spirit of our model, because companies whose values are harder to determine have more to gain from hiring experienced investment banks.

The probit results make it likely that the OLS coefficients indeed suffer from endogeneity bias. The final three columns of Table 3 report consistent 2SLS estimates allowing for the simultaneity of underwriter choice. The first stage estimates a least-squares version of our earlier probit regression, replacing the dummy dependent variable with *rank* itself.[29] The results, reported in the fourth column, confirm the probit estimates. In the second stage, we use the predicted *rank* from the first-stage regression as an instrument in the underpricing (fifth column) and wealth loss regressions (final column). This totally changes the relationship between *rank* and underpricing and wealth losses, compared to OLS: The coefficients estimated for *rank* are no longer significant and in fact become negative. This is more in line with the 1970s and 1980s evidence on the underpricing-reducing effects of underwriter prestige. It strongly suggests that the 1990s evidence of the underpricing-*increasing* effects of underwriter prestige is based on the false premise that underwriter choice is exogenous.

The coefficient of *rank* in the wealth loss regression is insignificant, just as we would expect. Changing to a higher-ranked underwriter should not reduce wealth losses at the margin if issuers behave optimally. In the underpricing regression, the coefficient of *rank* is negative, as predicted by certification arguments, but not significant ($t = -1$). Further investigation reveals this to be a problem of extraneous variables affecting the efficiency of our estimate. If we drop either of the insignificant risk proxies, the *underwriting fee* and ln(*sales*), or both, the (still negative) coefficient of *rank* becomes significant at $p = 9\%$, 4%, and 0.3%, respectively.

Finally, we note that our findings concerning the endogeneity of underwriter choice are robust to measuring underwriter prestige using market shares, as in Beatty and Welch (1996) and Megginson and Weiss (1991), rather than tombstone ranks.[30]

4. Conclusion

We began this article by asking why some IPOs are more underpriced than others. Notwithstanding the important contributions of the theoretical underpricing literature, we have suggested an alternative, non–mutually exclusive

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[29] Because $0 \leq rank \leq 9$, we also tried a Tobit specification with two-sided censoring and found our results qualitatively unchanged.

[30] We compute underwriters' market shares during the five years ending the quarter before each sample firm goes public. Specifically, we allocate the gross proceeds of each IPO during a five-year window equally to all banks involved as lead, co- or principal underwriters in that IPO (as listed in the top two segments in tombstone advertisements). To obtain each bank's market share, we then cumulate these allocated gross proceeds for each bank and divide by the total gross proceeds raised in all IPOs in the five-year window.

explanation: Some owners have less reason to care about the degree of underpricing and therefore will optimally expend fewer resources to minimize it. This explanation builds on two premises: (i) owners care about underpricing only to the extent that they stand to lose from it, with any such losses being proportional to the number of shares sold; and (ii) owners can affect the level of underpricing through the costs they incur in promoting the issue. Our model derives the empirical implications of these two premises for the relations among issuer wealth losses, underpricing, the costs of promoting the issue, the number of primary and secondary shares sold at the offering, and uncertainty. Our empirical tests on a sample of U.S. IPOs over the period 1991–1995 confirm our empirical predictions. We find that issuers indeed spend more to promote their IPOs, the more shares are being offered, and that these promotional activities reduce underpricing. We investigate one particular promotional choice, the choice of lead manager, and find that issuers choose their lead managers optimally once we adjust for the endogeneity of their choice.

We believe two results stand out from our analysis. The first result is that issuers optimize at the margin: Each additional dollar spent on promoting an issue reduces wealth losses by 98 cents, so marginal cost equals marginal benefit.[31] Such optimizing behavior is hard to reconcile with Loughran and Ritter's (1999) conjecture that "issuers treat the opportunity cost of leaving money on the table as less important than the direct fees." The second result is that accounting for the issuer's endogenous choice of underwriter may help reverse the counterintuitive positive relation between underpricing and the reputation of the lead manager reported for the 1990s by Beatty and Welch (1996) and others.[32] The key to this result is that issuers choose the quality of certification endogenously; it is precisely those issuers who would otherwise be most underpriced who stand to gain the most from choosing a prestigious underwriter to reduce underpricing. Consistent with this, we find that the most speculative companies choose the most prestigious underwriters. They may still be more underpriced than issuers who chose less prestigious underwriters, but less underpriced than they would have been had they chosen less prestigious underwriters themselves.

In conclusion, we caution against making inferences based on a comparison of underpricing alone. Consider, for example, Muscarella and Vetsuypens's (1989) empirical refutation of Baron's (1982) underpricing model. Baron views underpricing as compensation to the investment bank for revealing its superior information about market demand and as payment for marketing effort. Muscarella and Vetsuypens test this by looking at the underpricing experienced by a small sample of banks that underwrite their own flotations, which they find to be just as underpriced as IPOs in general.

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[31] The two-cent difference can presumaby be ascribed to statistical noise.

[32] For an alternative explanation, see Cooney et al. (1999).

However, concluding from this that Baron's model does not hold is premature: Though the banks certainly internalize the information rent, there is still the matter of the costs incurred in promoting the issues. Thus, it is at least conceivable that Muscarella and Vetsuypens's banks sell far fewer primary or secondary shares than do issuers in general, thereby leading to lower incentives to promote the issue and decrease underpricing.

Generalizing from this example, we argue that empirical tests should control for issuers' incentives by including the number of shares sold in an offering, and compute wealth losses rather than underpricing returns.

Appendix

Proof of Proposition 2. From the definition of wl, we have

$$\frac{dwl}{dn_{o,s}} = \left(\frac{1}{1+n_n}\right)\left(\overline{P} - \frac{\beta_U P_G + P_B}{1+\beta_U}\right) > 0$$

$$\frac{dwl}{dn_n} = \frac{n_{o,r}}{(1+n_n)^2}\left(\overline{P} - \frac{\beta_U P_G + P_B}{1+\beta_U}\right) > 0$$

and, noting that $P_G = \overline{P} + \frac{\Delta}{2}$ and $P_B = \overline{P} - \frac{\Delta}{2}$,

$$\frac{dwl}{d\Delta} = -\left(\frac{n_{o,s}+n_n}{1+n_n}\right)\frac{1}{2}\left(\frac{\beta_U - 1}{\beta_U + 1}\right) > 0$$

Note that we have used the Envelope theorem to neglect changes in exp and β_U.

From the definition of UP, we have

$$\frac{\partial UP}{\partial n_{o,s}} = \frac{1}{P_0^2}\left(\frac{\partial \overline{P}_1}{\partial n_{o,s}}P_0 - \overline{P}_1\frac{\partial P_0}{\partial n_{o,s}}\right)$$

$$= \frac{exp}{P_0^2}\frac{\partial \alpha}{\partial n_{o,s}}(\overline{P}_1 - P_0) < 0$$

where we have used the relations $\frac{\partial \alpha}{\partial n_{o,s}} = -\frac{n_n}{(n_{o,s}+n_n)^2} < 0$ and $\overline{P}_1 > P_0$. We also have

$$\frac{\partial UP}{\partial n_n} = \frac{1}{P_0^2}\left(\begin{array}{l}\left(-\frac{1}{(1+n_n)^2}\overline{P} + \frac{1}{(1+n_n)^2}\frac{\beta_U P_G + P_B}{1+\beta_U} - \frac{\partial \alpha}{\partial n_n}exp\right)\left(\frac{\beta_U P_G + P_B}{1+\beta_U} - \alpha \cdot exp\right) \\ +\left(\frac{1}{1+n_n}\overline{P} + \frac{n_n}{1+n_n}\frac{\beta_U P_G + P_B}{1+\beta_U} - \alpha exp\right)\frac{\partial \alpha}{\partial n_n}exp\end{array}\right)$$

which cannot be signed, and

$$\frac{\partial UP}{\partial \Delta} = -\frac{1}{P_0^2}\frac{\partial P_0}{\partial \Delta}\frac{1}{1+n_n}(\overline{P} - \alpha \cdot exp) > 0$$

where we have used the relations $\frac{\partial P_0}{\partial \Delta} = \frac{1}{2}(\frac{\beta_U - 1}{\beta_U + 1}) < 0$ and $\overline{P} - \alpha \cdot exp > \frac{\beta_U P_G + P_B}{1+\beta_U} - \alpha \cdot exp = P_0 > 0$.

Now turning to the total derivatives, we have

$$\frac{dUP}{dx} = \frac{\partial UP}{\partial x} + \frac{\partial UP}{\partial exp}\frac{\partial exp}{\partial x}$$

$x \in \{n_{o,s}, n_n, \Delta\}$ where $\frac{\partial UP}{\partial exp} = -\frac{1}{P_0^2}\frac{1}{1+n_n}(\alpha P_0 + (\overline{P} - \alpha \cdot exp)\frac{\partial P_0}{\partial exp}) < 0$.

The preceding inequality is true as

$$\frac{\partial P_0}{\partial exp} = \frac{\Delta}{(1+\beta_U)^2}\beta'_U(exp) - \alpha$$

$$> \left(\frac{n_{o,s}+n_n}{1+n_n}\right)\frac{\Delta}{(1+\beta_U)^2}\beta'_U(exp) - 1 = 0$$

where the inequality is true by recalling that $n_{o,s} < 1$ and $\alpha < 1$ and the equality is true by Equation (3).

Combining the preceding results with those of Proposition 1, we have $\frac{dUP}{dn_{o,s}} < 0$, whereas the signs of $\frac{dUP}{dn_n}$ and $\frac{dUP}{d\Delta}$ are indeterminate. ∎

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