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Agency Conflict in Pricing Initial Public Equity Offerings in the United States

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Abstract

Virtually all the published research addressing IPO pricing focuses exclusively on information asymmetry as an explanation for IPO mispricing. This paper establishes a new theory of IPO pricing based, in part, on an application of the behavioral theory of agency conflict inherent in the contractual relationship between the underwriter(s) and the issuer. A contribution of this paper is that is demonstrates how agency conflict is effected by judicial decisions and dominates information asymmetry as an explanation of IPO mispricing. The theory treats the price in the secondary market as a random variable governed by a density function with estimable parameters. A main result is a proof of a proposition: If underwriters estimate that an expected oversubscription at an offer price will be larger than the absolute value of the product of the probability of an oversubscription at that price and the demand at that price, they will recognize the offer is underpriced.

Keywords: IPO mispricing, agency conflict, information asymmetry

I. Introduction

The theory of IPO pricing developed in this paper is based, in part, on the manifestation of the agency problem recognized and reinforced by a New York State Appellate Court. The theory in the paper embeds the consequences of the agency problem in a model of an argument appearing in a recent paper by Ritter (2011.) He wrote:

> "*I argue that the evidence suggests that agency problems between issuers and investment bankers are of first-order importance in explaining both conditional underpricing and the average level of underpricing, and that the asymmetric information-based model with no agency problems that dominate the academic literature is at best of second order importance."*

Recently a decision in a New York State Appellate Court clarified the legal relationship between the underwriters and the issuer in a firm commitment initial public offering (IPO.) [1] The court ruled that the lead underwriter in an IPO does not owe a fiduciary duty to the issuer of securities to disclose conflicts of interest in connection with the pricing of the securities, unless the two parties have a distinct relationship of higher trust that arises apart from the underwriting agreement. The Court's decision has immediate practical implications for the apportionment of financial risks between the two entities.

Whether the lead underwriter of a public securities offering is an issuer's fiduciary is a crucial determination because it affects the standard of care owed by an underwriter to an issuer. [2] As a fiduciary, an underwriter would be obligated to act in the issuer's best interest and would owe a heightened level of care and loyalty. Alternatively, if, as the New York Appellate court held, an

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[1] On December 8, 2011, the New York State Appellate Division, First Department, held in *EBC I, Inc. v Goldman Sachs & Co.* that Goldman Sachs & Co., the lead underwriter for the IPO of common stock by EBC I, Inc., formerly known as eToys, Inc. was not eToys' fiduciary. **NY Slip Op. 08839**

[2] "*A fiduciary relationship exists between two persons when one of them is under a duty to act for or give advice for the benefit of another upon matters within the scope of the relation.*'" **Restatement [Second] of Torts § 874, Comment a.**

underwriter is merely the issuer's advisor, the obligations of the underwriter are purely contractual, resulting in a higher threshold for potential liability in the event of a dispute. The subordinate clause in the last sentence will be construed by underwriters to mean that in their negotiations with the issuer concerning the terms of the underwriting contract, they are not required to put the issuer's interests ahead of their own.[3]

The court stated that firm commitment underwriting relationships are inherently adversarial because the underwriter has an incentive to set a lower price (which makes it easier to sell shares in the offering), while an issuer seeks a higher price to maximize its proceeds from the offering. Such an adversarial relationship, the court held, cannot give rise to a fiduciary relationship.

The court's economic reasoning is correct, as far as it goes. However, it does not go far enough; the court's reasoning is biased because it fails to recognize the dual character of the risks assumed by the underwriter in a firm commitment offering.[4] This paper focuses on how information asymmetry can be exploited by underwriters to draft the terms of underwriting agreements in such a way as to minimize the dual risks to themselves of undertaking a firm commitment IPO. The legal decision cited above provides an additional incentive for the underwriters to engage in purely self-interested conduct because, absent a fiduciary relationship, they can do so with legal impunity in New York.

Recent evidence of material initial uncertainty about IPO values from Lowery et. al. (2010) indicates that the requirement to set a fixed-offer price exposes book-building underwriters to risk. Ibbotson (1975) recognized this but assumed that the best solution is to set the fixed-offer price equal to the expected post-offering price (i.e. the fair market value) of the new shares. Jones and Yeoman (2014) rigorously analyzed whether Ibbotson was correct, *absent other explanations such as agency conflicts … and asymmetric information*.

In Ritter's opinion (reproduced above), most authors have ignored the main explanation of IPO mispricing. The novel contribution of this paper is that it explores the hypothesis suggested by Ritter. The paper builds a theory of IPO pricings that explicitly reflects the agency problem.

II. Identification Of Dual Risks Faced By The Underwriters Of Equity IPOs

A cynosure of the academic literature relating to IPOs addresses the question of why they are "mispriced" so frequently. A representative statement (Adams, 2008) is: "*Why IPOs are consistently underpriced is a mystery*." In a paper published by Chen and Monahan (2002) the following statement appears:

> *"For over 20 years, researchers investigated the underpricing puzzle associated with initial public offerings (IPOs). Ibbotson (1975), Ibbotson and Jaffe (1975)*

[3] The New York Court's decision did nothing to change the law that underwriters can be held criminally and/or civilly liable if they engage in acts of fraud or if they make factual misrepresentations or if they conceal significant and relevant facts.

[4] The court's asymmetric reasoning regarding the underwriters' risk and incentive(s) is mirrored by similar reasoning found in the finance literature. For example, Chen and Mohan (2002) stated: "*We contend that underwriter spread may represent an explicit pricing of risk for an IPO issue and we find that it is significantly correlated with underpricing, which represents an implicit pricing of risk.*" That statement recognizes only one source of underwriting risk. Similar opinions are expressed in other publications of the same or later vintage. See Jones and Yeoman (2011.)

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> *and Ritter (1991) among others, adduce convincing evidence that initial public offerings are, on average, underpriced."*

A representative paper by Baron and Holmstrom (1980) suggests the issuer should design an underwriting agreement that nullifies the self-serving conduct of the underwriters to underprice the issue:

> *"In placing a new security issue, an investment banker has an opportunity to obtain private information by conducting preselling activities during the registration period. The task of the issuer is to design a contract that both induces the banker to use the information to the issuer's advantage and provides a disincentive for the banker to price the issue low in order to reduce the effort required to sell the issue*."

The "task" described in the paragraph reproduced above is addressed to the same perception of underwriting risk as was identified by the New York Appellate Court decision; the Court's decision and the published literature fail to recognize that there are really two manifestations of the underwriters' risk.

The most obvious risk is that the underwriter will be unable to sell the entire issue at the offering price. The counterpart risk is manifested whenever there is an upward spike in the market price at the date the issue goes public or very shortly thereafter. In that scenario the underwriter would have realized a larger profit, and the issuer would have realized an increase in its capitalization, if more shares had been issued at the offering price.

III. The Loci and Causes of Asymmetric Information

Before the formal registration statement is declared effective by the SEC, the members of the distribution syndicate can engage in preliminary marketing activities. The underwriters can gather "indications of interest" from potential investors. Those are statements by investors as to how many IPO shares they may be interested in buying and the price they are willing to pay. The preliminary marketing may include sales-force calls by underwriters' representatives to investors to educate them about the company. The underwriters set up meetings with senior management of potential investors and conduct a "road show" where the underwriters' representatives travel to key cities across the country making presentations to, and fielding questions from, potential investors. The managing underwriter records all the information gathered in a metaphorical "book" in a process known idiomatically as "book building." Fleuriet (2008) states that the result of these preliminary marketing activities is to create an asymmetry of information between the underwriters and the issuer. The asymmetry can be exploited by the underwriters, but not necessarily in the way suggested by most papers published about IPO pricing.

The risk to the participants in the distribution syndicate is the uncertainty regarding the number of shares that will be sold to the public at the offering price. The underwriters cannot forecast with certainty the latent demand of the investors at the offering price because the "book" they compile during the preliminary marketing is not a perfect forecasting vehicle. The market is not certain about the quality of the IPO. The issuing firm and its underwriters

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cannot know for certain what the after-market trading price will be in relation to the public offering price.[5]

A problem facing underwriters wanting to collect information useful for pricing the IPO is that potential investors have mixed incentives to truthfully reveal their private information during the pre-marketing phase. Prospective customers can bargain for a lower price, but they have a strong incentive to be at least truthful enough to be among those who will receive an allotment of shares when the offer is made. If they bluff to get a bargain price, they may see the shares go to customers who spoke frankly about their interest.

Benveniste and Spindt (1989) found that for institutional investors to reveal their true interest in the shares, they demand more underpricing. Those investors may make their interest known by specifying the number of shares they would be willing to purchase at the offer price. When investors make their indications known, they must factor in their expectations about the initial market price. From these indications of interest, the underwriter learns positive and negative information to be used to estimate a conditional probability distribution governing investors' the demand for shares. That information helps the underwriters to set the terms of the issue. [6]

One reason why the influence of information in underwriting agreements is of paramount importance is that previously published theories usually assume that the issuer or investors know (or learns) the "true value" of the IPO. As a practical matter, it is doubtful whether any participant in the IPO knows its "true value", except in greatly delayed hindsight.

Underwriters and issuing companies negotiate the number of shares, the offer price and the underwriters' compensation together and sometimes up to the last hours before the underwriting agreement is signed and the SEC declares the registration statement effective. If all is well, the offering "goes out the window" on the first day. By most accounts, the offer price is the last item negotiated within the book building process. However, there have probably been instances where the issuer and the underwriter have become deadlocked on the offer price at the 11th hour. In those instances the underwriter can agree to the offer insisted on by the issuer conditional on lowering the number of shares in the offering.

The underwriters do not have the unilateral power to set the offer price. However, if an issuer company adamantly insists on an unrealistically priced issue, in view of the hypothetical information acquired by the underwriters while they solicited "indications of interest," the underwriter can be equally adamant or propose a compromise. The underwriter can also abandon the deal if the issuer will not relent or compromise.

IV. The Significance of Information Asymmetry in an IPO

Various theories attribute the first-day IPO underpricing to the existence of information asymmetry between parties to the IPO process. The paper by Guo (2005) summarizes the loci and the cause(s) of asymmetric information. Of particular interest is the paper by Baron (2002). He proposed that underwriters know more about capital markets and potential

[5] Jones and Yeoman (2014) comment "*Even though it is fully subscribed by design, a bookbuilt IPO's value , or how the secondary market will price it, may be highly uncertain."*

[6] There have been extensive studies of the effect of public and private information on the offer price. In addition to the study by Benveniste and Spindt (1989) cited in the text, see Bradley and Jordan (2002), Edelen and Kadlac (2005), Hanley (1993), Loughran and Ritter (2002) and Lowry and Schwert (2002.)

investors than IPO issuers. To the extent that Baron's theory is valid, it can help to explain why underwriters' incentives can be exploited to the detriment of issuers.

Recently a paper by Chen (2010) examined the validity of Baron's model of IPO underpricing. Their paper compared self-marketed underwriters' IPOs with non-self marketed underwriters' IPOs and with IPOs they lead. Their empirical results show that Baron's model of IPO underpricing can be validated when issuer incentives are taken into account. The paper by Nguyen (2010) tested for the role of risk management in alleviating the degree of uncertainty relating to the value of the issuing firm and hence in lowering the underpricing return.

At the antipodal end of the spectrum of information is Rock's theory (1986.) It was tested in the paper by Balvers, *et. al.* (1993.) The theory models underpricing as a necessary compensation to uninformed investors who face an adverse selection risk. The Rock/Balvers theory focusses on the dichotomy between the sub-population of well-informed investors and the complement sub-population of investors who are uninformed. That theory is applicable to the dichotomy between the underwriter(s) and the issuer. The underwriters have undertaken costly research and investigations of the businesses and the finance of the issuing firm. Moreover, the underwriters' knowledge of the nuances of capital markets is (usually) vastly superior to that of the issuer. There is confirmatory evidence in a recent publication by Chong (2010.). That paper carried out an empirical study of H-share IPOs during the 1993-2003 period.[7] The authors concluded: "*We show that the degree of IPO underpricing is positively associated with the market conditions prior to issuance*."

The theory developed in this paper synthesizes some of the salient elements of the asymmetric distribution of information between the issuer and the underwriter(s).

V. The Definition Of A *Pro-Forma* Underwriting Agreement In A Firm-Commitment Equity IPO

The terms of the underwriting agreement in this model of underwriters' behavior are assumed to be very simple. A private company decides to issue and sell stock in an IPO. The underwriting syndicate undertakes a so-called a firm-commitment underwriting contract with the issuer. The underwriting agreement provides that the offering price, the underwriters' discount and the number of shares in the issue are determined by negotiations between the parties to the underwriting agreement.

I assume the lead underwriter is a non-fiduciary. The implication of that assumption is that the underwriter has an incentive to draft the terms of underwriting agreement in such a way as to minimize the risk to itself of the sale of the stock to the public. In the negotiations the underwriter has an opportunity to exploit whatever private information accumulates in the "book." As a practical matter, the lead underwriter is assumed to represent the interests of all the members of the distribution syndicate and he is assumed to conduct all the negotiations with the issuer's representative(s).

This paper models the underwriters' conduct in a bookbuilt equity IPO in three steps. First, the issuer informs the underwriters of the minimum dollar capitalization the issuer wants to realize from the IPO. Second, the underwriters and the issuer negotiate the number of shares and the share price to be paid by the underwriters to the issuer. That negotiation

[7] A special characteristic of H-shares is that they are shares of companies incorporated in China, but are also listed abroad.

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must satisfy the first condition. Third, the underwriters exploit their private information to determine the offer price. That exploitation will manifest the agency conflict in which the interest of the underwriters and those of the issuer are not aligned.

The symbols representing the terms of the agreement are these:
The total number of shares to be offered to the investing public is symbolized by S^*. I assume S^* is fixed by the terms of the underwriting agreement and cannot be altered.[8] The share price paid by the underwriter(s) to the issuer for each share is symbolized by P_i. The capitalization of the issuer at the date IPO goes public is $P_i S^*$. That is the dollar amount paid by the underwriters to the issuer and it must satisfy the minimum capitalization requirements stated by the issuer in step 1. From the point of view of the underwriting syndicate, it is the largest direct cost of a fixed-commitment underwriting.

The price at which the syndicate offers the shares to the investing public is symbolized by P. Thus, the underwriters' gross spread is $\Delta P = P - P_i$ for each share sold at the offering price in the secondary market.[9] Both prices are fixed in the underwriting agreement. Inasmuch as the underwriting syndicate purchases the entire issue directly from the issuer, that transaction is executed in the primary market.

If the public does not purchase all the shares offered by an IPO at the offering price, the investment banking firms acting as the underwriters for the offering may incur losses. When an offering is "sticky" Rule 101 of SEC *Regulation M* allows a firm to complete its participation in the distribution of shares by acquiring unsold shares for investment. This means that the shares must be held by the underwriters for a significant time period unless an exemption permits their sale.[10] However, the purchase of unsold shares for investment allows the firms to commence trading the shares which were sold to the public. [11]

After the issuer and the lead underwriter reach an agreement on the share price paid to the issuer, the underwriter can exploit his private information to try to influence the offering price to mitigate the risks to itself.

VI. Dichotomy of the Risks Assumed by the Underwriting Syndicate

I assume that the firm commitment underwriting agreement is drafted in such a way that the issuer avoids uncertainty: I assume the entire issue will be sold to the underwriters at a share price determined by the underwriting agreement. However, the virtual impossibility of pricing equity IPOs precisely in conjunction with the underwriters' proscribed hedging causes underwriters to assume dual risks. Here is a description of those risks considered exclusively from the point of view of the underwriters.

A The risk to the underwriters of underpricing the IPO.

One risk to underwriters is the risk that investors' aggregate demand for shares in the public market at the offering price exceeds the number of shares in the issue, i.e. the issue is oversubscribed. It is the market scenario described by the authors of many studies of IPO underpricing (Chen and Monahan 2002; Habib and Ljungqvist 2001; Jones and Yeoman

[8] The issuer might have the right to unilaterally withdraw the offer before the date of issue.
[9] The underwriters' gross spread is usually expressed as a percentage discount of the offering price; e.g. P_i is 93 percent of P.
[10] As a practical matter, the "significant time period" required by the SEC can be as long as a year.
[11] For further information on this subject, see the SEC Release dated December 20, 1996 n the adoption of *Regulation M* and its "No action" Letter regarding VLI Corporation, October 17, 1983 cited therein.

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2011.) In that case, the excess demand for subscriptions at the offering price will cause the transaction prices in the after-market to increase rapidly and perhaps very sharply.

The risks associated with underpricing are borne by the issuer as well as the underwriter. The issuer will sustain an obvious loss because its capitalization will be less than what it could have realized from the IPO if they had negotiated a higher price. Adams (2008) estimates that for the 15 year period antedating year 2008, the share price of the typical IPO closed roughly 15 percent above the offer price on the first day of trading. These high initial returns are captured by the original subscribers rather than by the issuer or the underwriters.

The underwriter(s) will sustain an opportunity loss for the same reason. The loss of revenue to the participants in the syndicate is measured by the spread on each share the underwriters could have sold at the offer price, but did not offer.

In an underpriced offering the participants in the underwriting syndicate cannot take advantage of the after-market price increase. An IPO offer price must be fixed, pursuant to Financial Industry Regulatory Authority (FINRA) "*Rules of Fair Practice*, " reflecting the Securities Act of 1933 and the Securities and Exchange Act of 1934 as well as the National Association of Securities Dealers' (NASD) *Rules of Fair Practice.* That rule is embedded in a popular law text-book, Coffey and Sale (2009.) The fixed price must be set before the offering goes public. All or part of the shares may be sold for less than the offering price, but shares may not be sold at a higher price. After the issuer and the underwriter agree on the offering price, it cannot be increased if the offering is over subscribed. That rule offers an incentive for the underwriter to negotiate with the issuer for a total number of shares in the issue to match the number of shares the underwriter expects to be demanded at the offering price.

B The risk to the underwriters of overpricing the IPO in the

The risk to the underwriters of overpricing the IPO is the risk that investors' demand for shares at the offer price is less than the number of shares issued, i.e. the issue is undersubscribed.

In the model to be developed below I assume the underwriters will sell as many shares as the market will purchase at the offer price. In a firm-commitment underwriting, I assume Rule 101 of SEC *Regulation M* is construed by the underwriters to mean they will regard the unsold shares, if any, as a long-term investment in their own trading account. By reason of the uncertain value of their long-term holding of over-priced shares I assume the underwriters do not consider that the hypothetical future trading price of the shares held in their own account should influence their IPO pricing decision. In other words, I assume the underwriters in a firm-commitment contract account for an undersubscription as a loss to themselves. The aggregate loss is measured by the underwriters' purchase of the unsold shares at the share price paid to the issuer.

VII. The Effect of Agency Conflict On IPO Pricing

As a practical matter, many IPOs during the last two decades have used bookbuilding, in which the offer price is set after indications of interest from institutional investors have been received, and in which underwriters have discretion for allocating shares. In consideration of that practice Ritter (2011) comments:

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> *"Given the use of bookbuilding in many countries, the observed levels of underpricing seem to be far in excess of what could be explained by the winner's curse problem."*

This statement by Ritter suggests to me an approach to studying the pricing of IPOs that looks deeper into the incentives and the behavior of the underwriters. Specifically, I assume the economic incentives facing the underwriters can conflict with the economic interests of the issuer because of the random character of the price in the secondary market. Notwithstanding the copious information collected by the underwriters, the theory in this paper is based, in part, on the proposition that persistent underpricing is attributable to unavoidable uncertainty respecting the equilibrium price of the IPO. That uncertainty can be represented by a random variable affecting the equilibrium price.

I assume that the book compiled by the participants in the distribution syndicate enables them to establish a continuous probability density function governing the investors' demand in the public market, conditioned on the offering price. I assume the underwriters express their uncertainty about the demand for shares S at an offer price P as a function of the offer price and a random variable x:

$$S = D(P) + x \tag{1}$$

(a) I assume $D(\cdot)$ is a deterministic and continuously differentiable function with the property $D' < 0$. This assumption corresponds to the conventional theory that the investors' demand for IPO shares on the date it goes public is a decreasing function of the offer price.

(b) I assume the underwriters regard x as a continuous random variable governed by the probability density function $g(x)$. I assume the density function governing x is independent of the offer price P. The effect of the offer price on the demand for shares at the opening of trading is embodied exclusively the function $D(P)$.

(c) Inasmuch as the investors subscribing to the IPO shares are buyers not sellers, the density function $g(x)$ is assumed to be truncated to assure $D(P) + x \geq 0$ for any $P > 0$.[12]

(d) I assume the process of book building allows the underwriters to estimate all the salient parameters of $g(x)$. In particular, I assume the underwriters' estimate the expected value of x to be equal to zero.

The four assumptions stated above allow the conditional expected demand for IPO shares, given an offer price P, to be calculated as:

$$E[S \mid P] = E[D(P) + x] = E[D(P)] = D(P) \tag{2}$$

[12] Condition (c) precludes the situation where an institutional investor can request to borrow shares with the intent of creating a short position by selling them. This is very rare and (understandably) the underwriters are not receptive to this tactic.

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Inasmuch as I assume the total number of shares in the issue is fixed at S^*, at an offer price of P the underwriters' gross profits from the offering can be expressed as a bifurcated function:

$$Underwriters' gross\ profit \quad =$$

$$\begin{cases} \pi_u \ = \ (\Delta P)S \ - \ P_i\,(S^* - S) & for\ S < S^* \\ \pi_f \ = \ (\Delta P)S^* & for\ S > S^* \end{cases} \tag{3}$$

The first segment, symbolized by π_u, represents the gross profits to the underwriters if investors do not take up the entire issue at the offering price; i.e. The issue is undersubscribed. The net income to the underwriters from the shares sold at the offer price is the product of the spread and the number of shares sold at the offer price minus the underwriters' costs of purchasing the balance of the unsold shares from the issuer at the price P_i.

The second segment, symbolized by π_f, represents the underwriters' gross profits if investors' demand for shares at the offer price is at least as large as the entire issue; i.e. The issue is oversubscribed. I assume the underwriters exhaust their allotment at the date of the IPO and they cannot sell more than S^* shares. In this scenario the underwriters experience an opportunity loss.[13]

The underwriters have direct costs, including the selling concession paid to the selling group and the management fee for advising the issuer and the costs of performing the due diligence examinations. I assume these costs are invariant with respect to the offer price.[14] That assumption obviates an explicit statement of the costs in the underwriters' objective function.

For mathematical convenience I define the probability density function $f(S) \equiv g(S - DP$. That is, f is a probability density function mapping such that: $f: x \rightarrow S$. The function f has the same mathematical properties as $g(\cdot)$ and its range is the same as the range of the random variable x .The advantage of defining $f(\cdot)$ is that it conduces to a calculation of the expected value of the underwriters' profits in terms of the random variation of investors' demand for shares conditioned by the offer price. Virtually all the published literature suggests that underwriters use the offering price as their instrument of control, *viz.* After the issuer and the underwriter determine the number of shares in the offering, the parties determine the offering price and the gross spread. It is at this point in the underwriting process that the agency conflict cited by Ritter's papers is manifested.

The theory in this paper is based on the proposition that underwriters use the private information in their book to determine an offer price to maximize their own expected gross

[13] The gross profit function π_f implicitly assumes that the so-called *Green Shoe* provision is not an option in the underwriting contract. That provision gives members of the underwriting syndicate the option to purchase additional shares from the issuer. The stated reason for the *Green Shoe* option is to cover excess demand and oversubscriptions. It is legally referred to as an over-allotment option. In the United States, when it is used, it is almost always equal to the regulatory maximum of 15% of the original issue.

[14] The paper by Lee, *et. al*. (1996) displays data showing that the aggregate direct costs of equity IPOs monotonically decrease as the value of the IPO increase. That evidence is consistent with the assumption in this paper.

profits. At this decision node in the negotiations between the issuer and the underwriter, the latter exploit their private information respecting the investors' expected demand for shares at the offering price.

The underwriters' expected gross profit is calculated as:

$$E[\pi] = E[\pi_u] + E[\pi_f] =$$

$$\int_0^{S^*} [(\Delta P)S - P_i(S^* - S)]f(S)ds + \int_{S^*}^{\infty} (\Delta P)S^* f(S)ds \qquad (4)$$

In order to analyze how the syndicate will adjust the offer price to manage the risks, it is necessary to characterize its (collective) attitude toward risk as well as its instrument(s) of control. The simplest attitude to impute to the syndicate, and the attitude adopted in this paper, is risk neutrality. Risk neutrality implies that expression (4) is the syndicate's objective function.
I assume the underwriters will exploit their asymmetric information advantage to draft an underwriting agreement to maximize that function.[15]

The optimal offer price is symbolized as P^*. It represents the offer price that maximizes the underwriters' objective function. Appendix A shows that the offer price which maximizes the underwriters' expected gross profit is displayed by equation (5).

$$P^* = \frac{E[S|P^*] - \int_{S^*}^{\infty}(S - S^*)f(S)dS}{-\int_0^{S^*} \frac{dS}{dP^*} f(S)dS} \qquad (5)$$

By reason of assumption 1(a), the denominator of equation (5) is positive.

Notice, the quantity in the numerator $\int_{S^*}^{\infty}(S - S^*)f(S)dS$ is the expected oversubscription for shares at the offer price P^*. That expectation informs the economic meaning of equation (5): The offer price which maximizes the risk-neutral underwriters' expect gross profits will be positive only if the expected demand for shares at that price exceeds the expected excess demand for shares at the same price. As the difference between those expectations shrinks, *ceteris paribus*, the optimal offer price will be adjusted downwards.
Conversely, as the expected oversubscription becomes smaller, *ceteris paribus*, the optimal offer price increases. This functional relationship is consistent with the economic theory of downward sloping demand curves.

If the underwriters attempt to set the offer price of the IPO in such a way that a secondary market equilibrium is achieved on the date the issue goes public, three conditions must be satisfied to achieve that result:

[15] The recently published paper by Jones and Yeoman (2014) also assumes that the underwriters' pricing strategy is carried out to maximize the risk-neutral underwriter's expected profit function. However, those authors expressly assume the impossibility of an advantage to any party conferred by asymmetric information. They state: "*We assume that immediately prior to the offering, all participants are uncertain and none has an informational advantage as to the fair market value* [of the IPO.]" In the opinion of the author of this paper, that assumption is implausible.

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(a) The offer price is set at a level such that the underwriters expect public investors will purchase the entire issue at the offer price; The underwriters do not expected the issue to be undersubscribed.
(b) The offer price is set at a level such that the expected excess demand for shares will be zero at the offering; The underwriters do not expected the issue to be oversubscribed.
(c) The closing price on the day of the offering will not be significantly different from the offer price at the opening of trading; The offer price represents the fair market value of the IPO.[16]

If the underwriters determine the offer price to achieve the market equilibrium characterized by the three conditions above, the offer price given by Proposition 1.

Proposition 1: If conditions (a), (b) and (c) are satisfied, the equilibrium offer price determined by the underwriters is:

$$\boldsymbol{P^*} = -\frac{\boldsymbol{D(P^*)}}{\left(\frac{\boldsymbol{dS}}{\boldsymbol{dP^*}}\right)\boldsymbol{Prob[S < S^*|P^*]}} \tag{6}$$

Considered from the self-interested point of view of the underwriters, the IPO is "*underpriced*" if an increase in the offer price, *ceteris paribus*, is expected to result in an increase in the underwriters' profit from the sale of shares at the date of issue. An implication is that the expected marginal sales revenue antedating the public sale can be calculated to determine the degree of underpricing, if any. The result is proved in Appendix B and expressed in Proposition 2.

Proposition 2: If the underwriters estimate an expected oversubscription at an offer price P^* to be greater than the absolute value of the product of the probability of an excess demand at that price multiplied by $\left[P^*\frac{dS}{dP^*}\right]$, they will recognize the offer is underpriced.

The expected opportunity loss to the underwriters of an underpriced IPO at an offer price of $P^*$is calculated as:

$$E[L] = P^*\int_{S^*}^{\infty}(S - S^*)f(S)dS \tag{7}$$

The derivative of $E[L]$ with respect to the offer price (evaluated at that price) is the change in the expected opportunity loss when the price changes.

$$\frac{dE[L]}{dP^*} = \int_{S^*}^{\infty}(S - S^*)f(S)dS + P^*\frac{dS}{dP^*}\int_{S^*}^{\infty}f(S)dS \tag{8}$$

Equation (8) implies Proposition 3.

[16] Jones and Yeoman (2014, p. 199) comment: "*For an underpriced offering, the fair market value should equal the aftermarket price at the end of the first day of trading.*"

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Proposition 3: The underwriters will adjust the offer price to a level where any change in the expected sales revenue in the secondary market equals the change in the expected opportunity loss in that market.

Proposition 3 implies that if a price smaller than P^* in equation (5) will fail to increase the expected sales revenue to the same extent that it increases the expected opportunity loss, the offer price will be increased. By the same reasoning, if a price larger than P^* will reduce the expected revenue to a greater extent than it reduces the expected opportunity loss, the underwriters will recue the offer price.

The theory developed in this paper explicitly models the consequences of agency conflicts and information asymmetry. The three propositions derived in this paper are not inconsistent with conclusions appearing in the Jones and Yeoman paper and they have the merit of showing how information asymmetry and agency conflict can be combined to explain mispriced IPOs.

VIII. Concluding Remarks

My concluding comments refer back to the New York Appellate Court decision appearing in the Introduction. The theory of underwriter behavior developed in this paper is consistent with that decision. The factual circumstances in that case are illustrative as well as suggestive of the practical implications of the theory of agency conflict as it is manifested in pricing IPOs.

In that case, the plaintiff represented the issuer of the IPO, namely eToys. The defendant, Goldman Sachs, was the lead underwriter. [17] In that IPO (in year 1999) eToys' 8.2 million share issue was underpriced by $57 per share, or almost half a billion dollars in all.[18]

The plaintiff alleged that Goldman Sachs was the plaintiff's fiduciary because eToys had relied on Goldman Sachs' expert advice in configuring the terms of its IPO and had placed trust and confidence in Goldman Sachs in doing so.

The following deposition testimony by the plaintiff's chief executive officer summarizes the information asymmetry as well as the manifest imbalance in the negotiating power between the issuer and the underwriter:

> ***Q.*** *Did you believe on May 19, 1999, that Goldman Sachs was giving you advice with the interest of eToys foremost in their mind* [sic]*?*
> ***A.*** *Yes.*
>
> ***Q.*** *Well you relied on them on May 19th ?*
> ***A.*** *We relied on them and . . . why did we rely on them?*
>
> ***Q.*** *Yeah.*
> ***A.*** *Because they're Goldman Sachs, for crying out loud, and they make a market and they take companies public. They completely control the process. They know how to do it. They get it done. They raise the money for us. They are the experts. They do this every day. We do this once in a life.*

[17] Technically, the plaintiff was the Official Committee of Unsecured Creditors of eToys, Inc., a bankrupt internet start-up company that was incorporated in 1996. By order of the United States Bankruptcy Court for the District of Delaware, plaintiff was granted standing as a representative of eToys' bankruptcy estate and authorized to prosecute any litigation claim on behalf of eToys and the estate.

[18] Ross, et. al.

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The veracity of the testimony reproduced above should not necessarily be accepted at face value. The witness may simply be attempting find someone other than himself to blame for his company's bankruptcy. However, to the extent that the attitude expressed in the witness's testimony is generally an accurate representation of the relationships between IPO issuers and their underwriters, the latter have opportunities as well as economic incentives to configure the terms of firm commitment IPOs in such a way as to minimize the risks to themselves of mispricing the IPO. If issuers cede to underwriters decisions respecting price parameters and the size of the issue, the theory developed in this paper explains how the underwriters can exploit asymmetric information to configure the size of the issue with little (or no) regard to the interests of the issuers. Moreover, they can do so with legal impunity in New York State.

The theory developed in this paper offers an explanation of why well-informed underwriters might exploit their private information to configure the terms of an IPO that results in mispricing the issue. The testimony reproduced above suggests in vivid terms the opportunities for such exploitation even if the issuer is reasonably sophisticated in business dealings.

In May 27, 2011, Rule 513(d) of the FINRA meliorated the information asymmetry in IPOs. Pursuant to that rule, the managing underwriter of a new issue must provide to the issuer's pricing committee (or board of directors) a regular report on indications of interest including the names of institutional customers. Significantly, FINRA did not impose any fiduciary obligation, but just required the reports as part of its rules of fair practice. Rule 513(d) will not necessarily eliminate all opportunities for underwriters to exploit their private information in the way described in this paper. The Rule will, however, lessen the imbalance in the information which enables that kind of exploitation.

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Appendix A

The offer price that maximizes the underwriters' expected gross profits for a fixed number of shares in the IPO is determined by finding the price that maximizes equation (4). This requires calculating $\frac{\partial E(\pi)}{\partial \Delta P}$, setting it equal to zero and solving for P.

Equation (4) in the text can be expanded to:

$$E[\pi] = (\Delta P)\int_0^{S^*} Sf(S)dS - P_i S^* \int_0^{S^*} f(S)dS + P_i \int_0^{S^*} Sf(S)dS + (\Delta P)S^* \int_{S^*}^{\infty} f(S)dS \qquad A1$$

Exploiting the fact that $\frac{df(S)}{d\Delta P} = 0$ by reason of the additively assumption with respect to the random variable x, we calculate the partial derivative of $A1$ as:

$$\frac{\partial E[\pi]}{\partial \Delta P} = \int_0^{S^*} Sf(S)dS + (\Delta P)\int_0^{S^*} \frac{\partial S}{\partial \Delta P} f(S)dS + P_i \int_0^{S^*} \frac{\partial S}{\partial \Delta P} f(S)dS + S^* \int_{S^*}^{\infty} f(S)dS \qquad A2$$

Recognizing $\frac{\partial S}{\partial \Delta P} = \frac{dS}{dP}$, equation A2 can be written as:

$$\frac{\partial E[\pi]}{\partial \Delta P} = \int_0^{S^*} Sf(S)dS + (\Delta P)\int_0^{S^*} \frac{dS}{dP} f(S)dS + P_i \int_0^{S^*} \frac{dS}{dP} f(S)dS + S^* \int_{S^*}^{\infty} f(S)dS \qquad A3$$

The expected demand for shares at an arbitrary price is symbolized by $E[S|P]$. It is calculated as:

$$\int_0^{S^*} Sf(S)dS = E[S|P] - \int_{S^*}^{\infty} Sf(S)dS \qquad A4$$

Substituting A4 into A3, we have:

$$\frac{\partial E[\pi]}{\partial \Delta P} = E[S|P] - \int_{S^*}^{\infty} Sf(S)dS + (\Delta P)\int_0^{S^*} \frac{dS}{dP} f(S)dS + P_i \int_0^{S^*} \frac{dS}{dP} f(S)dS + S^* \int_{S^*}^{\infty} f(S)dS \qquad A5$$

Setting equation A5 equal to zero and solving for ΔP, the result is:

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$$\Delta P = \frac{E[S|P^*] - \int_{S^*}^{\infty}(S - S^*)f(S)dS + P_i\int_0^{S^*}\frac{dS}{dP^*}f(S)dS}{-\int_0^{S^*}\frac{dS}{dP^*}f(S)dS} \qquad A6$$

Equation A6 can be simplified to:

$$\Delta P = \frac{E[S|P^*] - \int_{S^*}^{\infty}(S - S^*)f(S)dS}{-\int_0^{S^*}\frac{dS}{dP^*}f(S)dS} - P_i \qquad A7$$

The definition of the gross spread $\Delta P = P - P_i$ implies that equation $A7$ reduces to equation (5) in the text.

Appendix B

The denominator of equation (5) can be written as:

$$-\int_0^{S^*}\frac{dS}{dP^*}f(S)dS = \int_{S^*}^{\infty}\frac{dS}{dP^*}f(S)dS - \int_0^{\infty}\frac{dS}{dP^*}f(S)dS \qquad B1$$

Substituting the right side of B1 into equation (5) results in:

$$P^* = \frac{E[S|P^*] - \int_{S^*}^{\infty}(S - S^*)f(S)dS}{\int_{S^*}^{\infty}\frac{dS}{dP^*}f(S)dS - \int_0^{\infty}\frac{dS}{dP^*}f(S)dS} \qquad B2$$

Multiplying both sides of equation $B2$ by the denominator the result is:

$$P^*\left[\int_{S^*}^{\infty}\frac{dS}{dP^*}f(S)dS - \int_0^{\infty}\frac{dS}{dP^*}f(S)dS\right] = E[S|P^*] - \int_{S^*}^{\infty}(S - S^*)f(S)dS \qquad B3$$

The expression $B3$ can be rearranged to read:

$$E[S|P^*] + P^*\int_0^{\infty}\frac{dS}{dP^*}f(S)dS = P^*\int_{S^*}^{\infty}\frac{dS}{dP^*}f(S)dS + \int_{S^*}^{\infty}(S - S^*)f(S)dS \qquad B4$$

The demand for shares in the IPO is represented by equation (1). By the property of additivity specified in (1), the derivative of $D(P)$ with respect to P is independent of x. Thus, the derivative $\frac{dS}{dP^*}$ can be factored out of both integrals in $B4$. The result of factoring is:

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$$E[S|P^*] \quad + \quad P^* \frac{dS}{dP^*} \int_0^{\infty} f(S)\, dS$$
$$= \quad P^* \frac{dS}{dP^*} \int_{S^*}^{\infty} f(S) dS \quad + \quad \int_{S^*}^{\infty} (S - S^*) f(S) dS \qquad B5$$

The integral on the left-side of B5 is the integration of the probability density $f(S)$ over its entire range. Thus, equation B5 reduces to:

$$E[S|P^*] \quad + \quad P^* \frac{dS}{dP^*} \quad = \quad P^* \frac{dS}{dP^*} \int_{S^*}^{\infty} f(S) dS \quad + \quad \int_{S^*}^{\infty} (S - S^*) f(S) dS \qquad B6$$

The underwriters' expected gross revenue from its sales of shares at an offer price P^* is:

$$E[R(P^*)] \quad = \quad E[P^* S] \quad = \quad P^* \int_0^{\infty} S f(S) dS \quad = \quad P^* D(P^*) \qquad B7$$

Differentiating $B7$ with respect to the offer price we can calculate the underwriters' expected marginal revenue with respect to a change in the offer price:

$$Underwriters' \; expected \; marginal \; revenue$$
$$= \quad \frac{dE[R(P^*)]}{dP^*}$$
$$= \; D(P^*) + \; P^* \; \frac{dS}{dP^*} \qquad B8$$

The right side of equation $B8$ is the same as the left side of $B6$. It follows that:

$$Underwriters' \; expected \; marginal \; revenue$$
$$= \quad P^* \frac{dS}{dP^*} \int_{S^*}^{\infty} f(S) dS \quad + \quad \int_{S^*}^{\infty} (S - S^*) f(S) dS \qquad B9$$

Remembering that $\frac{dS}{dP^*} < 0$, if the sum of the terms in $B9$ is positive, an increase in the offer price is expected to result in an increase in the underwriters' revenue from the IPO shares sold to the investors. The underwriters' expected marginal revenue at the offer price is positive if and only if:

$$\int_{S^*}^{\infty} (S - S^*) f(S) dS \; > \; \left| P^* \frac{dS}{dP^*} \int_{S^*}^{\infty} f(S) dS \right| \qquad B10$$

If the inequality in $B10$ is satisfied, the IPO is mispriced at the *ex ante* offer price because an increase in the price, *ceteris paribus*, is expected to result in an increase the IPO revenue. This proves Proposition 2.

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