IPO ANOMALIES, TRUNCATED EXCESS SUPPLY, AND HETEROGENEOUS INFORMATION

Roy H. M. Sembel
J.M.Katz Graduate School of Business, University of Pittsburgh
Comments and suggestions are welcome.
(412) 621 8547, e-mail:rhsst7+@pitt.edu
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Abstract

In this paper, I propose a new explanation of IPO anomalies ('underpricing', long-term underperformance, and hot/cold issue period), and develop a simple theoretical model to capture the idea. The existing popular explanations of IPO anomalies are based on the notion of deliberate actions (deliberate 'underpricing', price stabilization, etc.) by the firms/underwriters or irrationality/overreaction by investors. My model is based on the assumption that the investors are rational and the firms/underwriters on average do not misprice the IPOs. The positive average initial return of IPO is a natural consequence of the heterogeneous information facing rational investors and the IPO procedures that cause an average excess demand. The other anomalies and related empirical evidence, such as the certification hypothesis, the partial adjustment phenomenon, are also reviewed using the model as the framework of analysis.

I. INTRODUCTION
II. IPO ANOMALIES AND EXISTING EXPLANATIONS
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I. INTRODUCTION

Capital is the bloodstream of firms/corporations. There are several ways firms can acquire capital.[1] Selling stock to the general public is one important way to do it. When a firm raises capital by selling shares for the first time to the general public, the offering is called the initial public offering. The stock offerings usually involve investment bankers.[2] Initial public offerings (IPOs) are man-hour-intensive deals for underwriters and important big decisions for the private owners of firms. Each year there are a lot of firms launching their initial public offerings (see table 1).

Table 1. Volume of IPOs (USA)

Year	80	81	82	83	84	85	86	87	88	89	90	91
Number of IPOs	259	438	198	848	516	507	953	630	435	371	276	367

[1] For an excellent discussion of problems/anomalies related to the capital acquisition process, see Smith (1986).

[2] For a theoretical discussion about underwriting agreement between firms and investment bankers, see Mandelker and Raviv (1977), Bower (1989).

Source: Loughran et al, 1994.

IPO has always been an interesting research topic for decades. IPO involves a large sum of money and yet several phenomena are still puzzling. For example, right after the IPO, the prices of the stocks on average jump significantly causing a large average initial return (many researchers call it *'underpricing'* phenomenon/anomaly). However, in the long run, the IPO stocks on average underperform the market (the *long-term underperformance* anomaly). In addition, there is an apparent cycle of period with high and low initial returns (the *hot-cold issue* phenomenon).

Existing explanations for the phenomena are still not satisfactory. Some explanations based on underpricing by underwriters, investors rationality and market efficiency can explain the existence of the 'underpricing' anomaly but can not explain the long-term underperformance anomaly. Other set of explanation can explain the anomalies, but it is based on investors' irrationality and overreaction, and does not give economic reasons why they fail to behave rationally and/or why the investors consistently overreact (as opposed to underreact). A more complete comprehension of the phenomena is useful for all parties involved in the IPO process. Research to look for new or complement explanations are still needed. The objective of this article is to find an explanation that can explain the IPO anomalies without having to assume investors irrationality, and build a simple model to capture the idea.

I develop and model a different view for explaining the anomalies. Unlike the mainstream explanations that assume underwriters set the initial price deliberately below their valuation, my model is based on assumptions that the underwriters price the IPOs exactly at their valuations and their valuations on average hit the full information value of the firms. Furthermore, it is based on investor rationality assumptions and takes into account deviations from perfect market conditions caused by the IPO procedures. These circumstances are shown to imply the existence of the IPO anomalies.

My simple model turns out to have rich implications that can explain not only the 'underpricing', long-term underperformance, and hot/cold issue phenomena, but also other related empirical evidence on IPOs such as the relationship between 'underpricing' and uncertainty, cross sectional variation in the IPO initial returns, certification hypothesis, etc. I also explore the implications of the model on the over-allotment option, IPO volume, institutional investors' role, etc.

Chapter II describes the IPO anomalies and the existing mainstream explanations. Empirical evidence and arguments are presented to show the weaknesses of the existing explanations. Also, in this chapter, I briefly explain the differences between my model and the existing explanations. Chapter III discusses my model. First, the intuition behind the model is presented. Second, the simple formal model is developed. Then, the IPO anomalies and other related empirical evidence are analyzed using the model as the point of reference. Some ways to directly test my model are also suggested. The summary, conclusions, and further possible extension/future research agenda are given in chapter IV.

To make the model easier to follow, the IPO procedures and example of IPO time table are described in the appendix. 1.

II. IPO ANOMALIES AND EXISTING EXPLANATIONS

II.1. IPO Anomalies

As a result of previous empirical research, researchers have found some interesting IPO anomalies. There are three most important and puzzling IPO phenomena:

1. Short-term 'underpricing' of IPO stocks

Ibbotson (1975) documented an early comprehensive evidence of positive initial return of IPO stocks.[3] Using monthly IPO data 1960-1969, he documented an average initial return of 11.4%. Using more comprehensive IPO data 1960-1992, Ibbotson, et al (1993) documented an average initial return of 15.3%. This phenomenon is not specific to the IPOs in the USA. Positive initial returns are also documented for other countries with relatively established stock market such as UK, Germany, as well as countries with emerging stock market like Hongkong, Malaysia, etc. (see table 2)

Table 2. Evidence of positive initial return of IPO stocks

Source	Country	Period	Initial Return[4]
McDonald & Fisher (1972)	USA	1969	28.5%
Ritter (1984)	USA	1960-82	18.8%
Ibbotson (1975)	USA	1960-69	11.4%
Ibbotson et al. (1993)	USA	1960-92	15.3%
Hwang & Jayaraman	Japan	1974-89	20.3%,98.0%*
Levis (1993)	UK	1980-88	14.3%
McGuiness (1992)	Hongkong	1980-90	17.6%
Dawson (1987)	Malaysia	1978-83	166.6%
Koh & Walter (1989)	Singapore	1973-87	27%
Finn & Higham (1988)	Australia	1966-78	29.2%
Keloharju (1992)	Finland	1984-92	9.6%
Jog & Riding (1987)	Canada	1971-83	9.3%
Kim & Lee (1990)	Korea	1984-86	37%
Wessel (1989)	Netherlands	1982-87	5.1%
Uhlir (1989)	F.R.Germany	1977-87	21.5%

[3] The initial return is defined as (AP - OP)/OP x 100%
AP = Aftermarket price (end of the offering month/week/day price)
OP = Offering price

[4] Whether or not the numbers are market and/or risk adjusted should not really matter. The period of the initial return is relatively short (one day to one month). It is very unlikely that the adjustment will nullify the huge level of the positive average initial returns.

Aggarwal, et al (1993)	Brazil	1980-90	90.2%
Aggarwal et al (1993)	Chile	1982-90	19.1%
Aggarwal et al (1993)	Mexico	1987-90	33%

* The latter is the average initial return for IPOs whose opening were delayed due to excessive demand, the former is for the non-delayed IPOs.

It is puzzling that the price of IPO shares on average jumps in the after-market. The jump cannot be explained by the market movement. If this phenomenon is really what its name ('underpricing') connotes then it may hurt the firms. It implies that the firms on average get less than what they deserve. The implicit assumptions behind the terminology 'underpricing' are the prices in the after-market reflect the market-perceived true value of the firm while the prices set by underwriter/firm in the initial market (the offering prices) are on average below the market-perceived true value of the firm.

2. Long-term underperformance of IPO stocks

Empirical evidence on this anomaly is relatively still in the early stage. An early evidence of long-term underperformance was documented by Stern and Bornstein (1985). Out of 1922 IPOs between January 1 1975 and June 30 1985, they found only 600 IPOs (31%) performed better than the contemporaneous S&P 500 index. Another important article in this area is the article by Ritter (1991). Using IPO data 1975-84 Ritter found that in the after-market, IPO stocks underperformed the market after about three years of seasoning. The evidence of underperformance is later updated and confirmed by Loughran & Ritter (1993) using IPO data 1970-89. Long-term underperformance was also documented by Keloharju (1993) for IPO in Finland, Levis (1993) for UK, Aggarwal et al (1993) for Brazil, Chile and Mexico, but was insignificant for IPO in Japan according to research by Hwang & Jayaraman (1992).[5] [6]

As a result of the short-term 'underpricing' and the long-term underperformance, the cumulative abnormal returns[7] of the IPO stocks form a pattern given in Figure 1.

3. Hot and cold issue cycle

Hot issues are defined as stock issues whose prices have risen from their offering prices to higher than average premia in the after-market. Hot issue IPO markets happen when

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[5] Hwang & Jayaraman used the data from the bull market of the 1980s up to 1989. The Japanese market fell sharply since the market peak at the end of 1989. Their results are also sensitive to the benchmark used.

[6] Another possibly related anomaly is the underperformance of newly listed stocks on the NYSE and AMEX during the postlisting period. Makhija, et al, (1989) found that this anomaly was not caused by (temporary) reduction in the riskiness of the stocks after the listing. Using data of 2,235 newly listed stocks 1965-1984, they found evidence that instead of lower risk after listing, riskiness was greater than in later periods.

[7] $$CAR(T) = \sum_{t=1}^{T} (r_t - b_t)$$

CAR(T) = Cumulative Abnormal Return at from time 0 to time T

r_t = return of the IPO portfolio from time t-1 to time t (t=0 is the offering time)

b_t = return of the benchmark portfolio from time t-1 to time t

average initial returns on the new issues are abnormally high for a prolonged period. Ibbotson & Jaffe (1975) and Ritter (1984) found that the degree of 'underpricing' (initial return) varied from period to period and formed a cycle of high (hot) and low (cold) initial return and sometimes varied from sector to sector. The cycle is also visible for the IPO volume.

II.2. Existing Explanations of the Anomalies

A lot of research are devoted to searching the explanation of the anomalies. Most of the research looked for explanations of the 'underpricing' phenomenon. The mainstream explanations can be categorized into three groups: Underpricing, overreaction, and other (miscellaneous) explanations. In general, the underpricing-based explanations argue that for some reasons, the offering price is deliberately set by the firm/underwriter below the market-perceived true value per share. In the immediate after-market, price correctly reflects the market-perceived true value per share, therefore the price will be higher than the offering price. As a result, a positive initial return will be observed. This explanation can not explain the occurrence of the long-term underperformance anomaly. The second group of explanations (overreaction) can explain the 'underpricing' as well as the long-term underperformance anomaly. However, the word overreaction and the view that investors are irrational are very uncomfortable and hard to swallow for most finance scholars that believe in the rationality of investors.

1. Underpricing-based explanations:

1.1. Compensation against risk. Under a firm commitment contract, underwriter will have to absorb the remaining new issue stocks that cannot be absorbed by the market (e.g., because of overpricing). 'Underpricing' -this explanation suggests- is a way to compensate the risk averse underwriter against this risk. However, it is not clear whether this mechanism is efficient to compensate the underwriter. It is always possible to take this risk into account directly in the underwriter compensation contract. In addition, this explanation also implies that the firm commitment IPOs should be underpriced more than the best efforts IPOs. Empirical evidence does not support this implication. Using 1977-1982 IPO data, Ritter (1984) found that best efforts IPOs were on average 'underpriced' more than the firm commitment ones (average initial returns: 47.78% for best efforts offers, 14.80% for firm commitment offers).

1.2. Mitigation of winner's curse. Some researchers argue that the 'underpricing' is set deliberately by the firm/underwriter to mitigate winner's curse problem facing the uninformed investors (Rock[1986], Beatty and Ritter [1986]). According to this explanation, the informed investors, who know the market-perceived true value of the stock, only submit their bids if the offer price is less than the market-perceived true value per share. The uninformed investors do not know whether the price is higher or lower than the market-perceived true value per share. Therefore if the uninformed investors were to submit bid in every IPOs, they would face an unfortunate situation: when the offer price is greater than the market-perceived true value (overpricing) the probability of the

uninformed getting allocation is relatively high, because the number of investors submitting bid is relatively small (since the informed investors do not participate), and when the offer price is less than the market-perceived true value ('underpricing') the probability of getting allocation is relatively low, because the number of investors submitting bid is relatively large (since the informed investors participate). This is called the winner's curse phenomenon: when the uninformed investors get allocation (become a 'winner'), it is more likely that the stock is overpriced. Therefore the return on investment for the uninformed investors is lower than the unconditional return. To induce the uninformed investors to submit bid, IPOs should be on average underpriced. Implicit assumption behind this explanation is that the demand from the informed investors is not sufficient to absorb the IPO stocks. However, the empirical evidence indicates that it is very common for the new issues to be oversubscribed significantly. For example, the oversubscription of IPOs in Singapore is on average 29.4 times the offering size (Koh and Walter [1989]). Moreover, even if the demand from the informed investors is not sufficient, there is still a potential free rider problem among the issuers. The issuers know that in aggregate IPOs should be underpriced to attract the uninformed, but individual issuer has incentive to free ride, i.e., to deviate from 'underpricing' scheme and let the other issuers underprice their issue.

1.3. Leaving good taste in investors mouth or signaling the quality of firms. Some researchers argue that 'underpricing' is a way of high quality firm to signal its quality. Grinblatt and Hwang [1989], Allen and Faulhaber [1989], Welch [1989][8] developed formal models to capture this idea. Under some range of parameters' values a separating equilibrium exists in which the high quality firm will underprice its share in the IPO market while the low quality firm prefers not to mimic the high quality firm's action. The high quality firm can afford to underprice in the first issue because it can recover the lost in the subsequent issues after their true quality is revealed, i.e., the total proceed from the IPO market plus the seasoned market is larger than what it will receive if it does not underprice (in which case a pooling equilibrium exists, both high and low quality firm will be valued at the same price, the average price, based on the average quality). Thus, the positive initial return is a result of the underpricing by the high quality firm under the separating equilibrium conditions. Using a sample of 494 IPOs between January 1 1980- December 31 1983, Garfinkel [1993] found evidence that did not support this explanation:
- 'underpricing' has an insignificant effect on the likelihood of reissue after controlling for other variables that may affect both the probability of reissue and 'underpricing'.
- 'underpricing' has no significant impact on the probability that insiders will sell shares in the open market some time after the IPO (under signalling theories, firms with greater 'underpricing' should exhibit greater insider selling in the after-market), after controlling for ex-ante uncertainty, the firms' post IPO stock price performance, and the partial adjustment phenomenon.

1.4. Exploitation of inexperienced issuer, principal-agent conflict. This explanation suggests that investment bankers/underwriters take advantage of inexperienced issuers by

[8] Another classic signalling-like theoretical model, that is not developed specifically for IPO, is Leland and Pyle (1977).

'underpricing' their IPOs. 'Underpricing' makes it easier for the underwriter to market the issue. The explanation fails to take into account the long-term reputational effect of cheating and the possibility of the new issuers to learn from previous historical performance of the underwriters combined with the competition among the underwriters. Other researchers see 'underpricing' as an agency conflict between the firm -the principal- and the underwriter -the agent- (Barron, [1982]). In Baron's model, the underwriter is better informed about the appropriate price of the new issued stock. New firms that want to go public seek pricing advice from the underwriter. The underwriter has an incentive to underprice the issue because the lower the price the less effort the underwriter must expend to market the new issue and also the lower the probability that the underwriter has to absorb the remaining unsold stocks because the issue is undersubscribed. Interestingly, this model implies that if the issuing firm is an investment banker/underwriter, there should not be any 'underpricing'. This implication is tested and refuted by Muscarella and Vetsuypens [1989]. Using 38 IPOs of investment banking firms who market their own IPOs, they found that the issues were 'underpriced' at a similar level compared to other regular IPOs. That is a direct evidence against the principal-agent explanation.

1.5. Insurance against lawsuits. This explanation is based on the fact that in the USA, investors can sue an investment banker to recover damage of buying bad IPOs. The 'underpricing' is a form of insurance against lawsuits launched by the IPO buyers if the after-market price drops (Tinic, [1989]). Firms/underwriters underprice the issue to reduce: (i) the probability of lawsuit, (ii) the conditional probability of adverse judgement if a lawsuit is filed, (iii) the amount of damages in the event of an adverse judgement. Drake and Vetsuypens [1993] studied 93 IPOs that were later sued. Their findings do not support Tinic's hypothesis. They found no significant relation of 'underpricing' and probability of being sued. Law suit occurs after a significant drop in the after-market performance (as opposed to initial overpricing).[9] The 93 IPOs are not overpriced, but instead as 'underpriced' as other IPO stocks of similar size. In addition, the law suits are usually a class action ones. All shareholders who bought shares within about 15 months after the IPOs are eligible. The eligibility of the after-market shareholders makes the initial 'underpricing' irrelevant. International evidence of 'underpricing' in the countries where there are no lawsuit against IPO firms also support Drake and Vetsuypens conclusion. In these countries, 'underpricing' phenomenon still exists.[10] Thus, this insurance hypothesis can not be a major driving force to generate the 'underpricing',

1.6. Cascade behavior. Welch (1992) suggested that if the sales of the IPO are done in sequence and investors who are offered later can observe the decisions of investors who are offered earlier, then if the earlier investors decline the offer, the later investors will revised their valuation downward. If the earlier investors happen to be investors who have lower valuation, the cascade behavior will result in the failure of the IPO. To reduce the probability of failure caused by this cascade/domino effect, the IPOs need to be underpriced. Notice that the implication of model is very sensitive to the questionable

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[9] The significant price drop is usually caused by bad news about firm's financial condition, and shareholders who file law suit often claim that the insiders knew this unfavorable development before the offering but did not properly disclose this information.

[10] For comprehensive review of IPO underpricings in many countries see Loughran et al (1994).

assumption that the investors can observe the decision by the earlier investors. Also, it can not explain the long-term underperformance anomaly.

1.7. Cost of soliciting information. Other hypotheses try to explain 'underpricing' for example by combining Rock's winner's curse hypothesis and the cost of soliciting information during the marketing process (Benveniste & Spindt [1989], Benveniste & Wilhelm [1990]). Similar to the other underpricing-based explanations, it can not explain the long-term underperformance anomaly.

Common to the previous explanations is the notion that the positive IPO return is a result of deliberate actions (deliberate underpricing) of the firms/underwriters and the explanations suggest reasons for the rational underwriters to underprice the IPOs. The explanations treat the investors as a homogenous group or at most consisting of only two types (informed vs uninformed). I propose that the positive average initial returns/'underpricing' phenomenon can be observed even without any deliberate actions of firms/underwriters to underprice the IPO relative to the underwriters' valuation. In my model, the positive average initial return is a result of the difference/heterogeneity in the information set facing different potential investors, average excess demand and the rationing (fixed price and fixed supply) mechanism of the IPO, while the underwriters price the IPOs on average at the market-perceived true value per share.

2. Overreaction

Another set of explanation is called the overreaction hypothesis.[11] According to this explanation, the underwriter sets the price correctly and the positive initial return can be viewed as an overreaction (fad) of irrational investors in the after-market. This point of view was suggested and investigated for example by Ritter (1991), Aggarwal & Rivoli (1990). The name 'overreaction' connotes an irrational conduct/decision making by investors in the after-market. The arguments are mainly based on behavioral and psychological reasons. Proponents of this argument are struggling to rationalize their view that (i) the investors can consistently be irrational/overreact, and (ii) the overreaction is only one way (on the positive return).

Unlike the existing hypotheses, my model is based on assumptions that the underwriter/firm on average set the price at the market-perceived true value per share and all buyers/investors are rational. Investors as a whole on average (inter-temporally or over time periods) react correctly (Supply = Demand at the market-perceived true value per share). The seemingly consistent overreaction is observed because IPOs with (extreme) excess supply are truncated and hence excluded from the observed data. The model turns out to have rich implications that can explain the three IPO anomalies and other related empirical evidence on IPO.

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[11] The overreaction hypothesis has its root in some research on stock prices behavior by Werner F De Bondt, Richard H. Thaler, Robert Shiller, etc. Some of their important works are collected in: Richard Thaler (ed.), 1993, *Advances in Behavioral Finance*, New York: Russell Sage Foundation.

3. Price support/stabilization by underwriter.

According to this explanation, positive initial return is a result of price stabilization/price support by underwriter in the after-market. The price support will truncate the left tail distribution of the initial return resulting the observed positive initial return (Hanley, Kumar, Seguin [1993], and Ruud [1993]). Price stabilization is a costly exercise for the underwriter. It has been argued that price support is one way to avoid lawsuits. If the IPO is really overpriced, in the medium/long-run market will know it. The evidence from the law suits suggested that it is the long-term underperformance that affects the probability of being sued, not the initial return. Therefore, the avoidance of lawsuits is not a compelling reason for price support. Hanley et al (1993) found that market prices decline by only 2.5% over the following five days after the stabilization is assumed to be suspended. The magnitude of the price drop (2.5%) is relatively small compared to the average initial return. Nevertheless, this explanation is interesting, because it is not based on the underpricing argument, it does not assume investors' irrationality, and to some extent, it also implies some time in the after-market price will drop (i.e., after-market underperformance, after the stabilization activity is abandoned).

4. *Hot/cold IPO markets*

Explanations of the hot-cold issue cycle are usually indirect implications of the explanation of positive initial return. For example, Ritter (1984) used the Rock's winner's curse model to develop the changing risk composition hypothesis. Using an implication of the Rock's model that there is a positive relation between uncertainty and underpricing, the changing risk composition hypothesis predicts that IPO markets during hot issue periods consist of firms with high risk. Ritter claimed that he found evidence that did not support changing risk composition hypothesis because the relation between risk and initial return was not linear and stationary. However, he did find that the hot IPO market (1980-81) consisted of riskier firms, and the initial returns are positively related to the some measures of firms' risk. Claiming that the hot issue market was industry specific (attributable to IPOs of new firms from the natural resource industry), Ritter suggested an alternative explanation. He argued that the monopsony power of the fringe underwriters might have been exercised against the natural resource firms. This monopsony power, in turn, caused the high level of 'underpricing'. Dunbar (1992) reexamined Ritter's findings by separating the IPOs based on the underwriting contract: Best efforts vs firm commitment. He found that the hot issue market of 1980-81 was not industry specific.

III. MODEL AND IMPLICATIONS

III.1. The Intuition

1. General ideas

Because of costly information and limited wealth, investors will only search for information until its marginal cost equals expected marginal revenue. Different investors find different information subset (although the information subset can be overlapping due to some common public information).

The differential information facing different investors causes some investors to value the firm's share higher or lower than the market-perceived true value. This diversity in valuation, combined with the limited wealth available for IPO investment, result in a downward sloping demand curve. It is assumed that on average the firm/underwriter set the price correctly at the market-perceived true value per share. When demand exceeds the fixed supply at the offering price, rationing occurs. Some investors -who based on his information set- value the share highly but do not receive allocation at the initial price will bid the price up in the after-market. A new equilibrium is achieved at a price higher than the initial price. A positive initial return is observed.

2. Average excess demand

The first task is to explain why on average there will be an excess demand in the initial market. During the pre offering period, the underwriter comes up with a valuation of the firm, a price estimate of the firm's stock, number of shares to be sold, and then receives preliminary indications from potential investors about the (potential) market demand at that price. When the market demand at that price is very disappointing, the underwriter can always (advise the firm to) withdraw the offering.[12] Note that even the firm commitment contract is not signed until a couple of days before the offering. As a result, when an IPO is carried out, what is observed is a truncated distribution of excess demand, i.e., the extreme excess supply (or the negative excess demand) is cut off, such that the observed excess demand is either about equal to zero or positive.
Suppose when the price is equal to the market-perceived true value the excess demand is $\tilde{X}$ = Demand - Supply. Unconditionally (inter-temporally or over time periods), $\tilde{X}$ is distributed as q(x), where q(x) is a density function with zero mean. For any $\hat{x}$,

$$E(\tilde{X}) = \int_{-\infty}^{\tilde{}} x\, q(x)\, dx = \int_{-\infty}^{\hat{x}} x\, q(x)\, dx + \int_{\hat{x}}^{\tilde{}} x\, q(x)\, dx = 0.$$

$$\Leftrightarrow \int_{\hat{x}}^{\tilde{}} x\, q(x)\, dx = -\int_{-\infty}^{\hat{x}} x\, q(x)\, dx)$$

The conditional density of $\tilde{X}$ given $\tilde{X} > \hat{x}$ is

$$q(x \mid \tilde{X} > \hat{x}) = q(x)/L, \text{ where } L = \int_{\hat{x}}^{\tilde{}} q(x)\, dx.$$

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[12] For example, for the period from January 1 1980 to December 31 1981 Dunbar (1992) found 326 successful (76%) vs 105 withdrawn (24%) firm commitment IPOs, 119 successful (61%) vs 76 withdrawn (39%) best efforts IPOs.

If left tail ($\tilde{X} < \hat{x} < 0$) is truncated, then

$$E(\tilde{X} \mid \tilde{X} > \hat{x}) = \int_{\hat{x}}^{\tilde{}} x \frac{q(x)}{L} dx = -\int_{-\tilde{}}^{\hat{x}} x \frac{q(x)}{L} dx > 0,$$ because $q(x) > 0$ and for the left tail, $x < 0$.

Thus, on average, there will be a (positive) excess demand.

Another factor that also contributes to the observed average excess demand is the possibility for the firm to time the IPO. Even before the firm enters into a negotiation with an investment banker, the firm can make its own investigation about the potential price/demand schedule of its share. If the firm feels that the current market condition is too weak to absorb its share, it can always wait for a while until a window of opportunity appears.[13]

3. Underwriters

Unlike the existing explanations that take a view that the underwriters deliberately set a price lower than their estimate of the market-perceived true value per share, my model take a view that the price set by the underwriter in the initial market on average matches the market-perceived true value per share (value per share conditional on information collected by the market as a whole) while the (immediate) after-market price is bid up by some rational investors based on limited information that the investors possess at that particular point in time.

A legitimate question arises: If there are investors that will bid the price up in the after market, why do the underwriters not set the initial price equal to the after-market price? If one takes a short-term view, the statement sounds very compelling. The problem with the statement is, the underwriters are long-term players who 'play' the IPO game not just once. Their *reputation (in the investors' point of view)* is the key here. When an underwriter values a company stock at Pa but sell it at Pb > Pa, sooner or later the investors will learn this overvaluation. If the underwriter continue to play this 'overpricing' game, in the long run the investors will notice it and will punish the underwriter by stop doing business with the underwriter or even worse, the investors may sue the underwriter. It will further ruin the underwriter's reputation and makes it difficult for the underwriter to attract investors for future IPOs. This reputational notion is substantiated by a 'wisdom' among practitioners to seek a highest <u>sustainable</u> price for IPO instead of a highest <u>attainable</u> price.[14] When the underwriter set the price at Pa, it is confident that the price is sustainable. As an added bonus, the underwriter and the firm will enjoy a good publication when the media report the IPO as a winner (i.e., experiencing price

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[13] For a recent example of a firm timing its IPO, see Glenn Rifkin, "Anatomy of a Highflying IPO, Nosebleeds and All," *The New York Times*, February 19, 1995, p F7. Shiva corporation, a software maker, originally hoped to launch its IPO by summer 1994. After shoping around, Shiva management found that at that time, market condition was not favorable for the high tech sector. The management decided to wait. Finally, around the beginning of fall season 1994, the market for high tech rebounded. The wait paid off. Shiva IPO turned out to be a highflying IPO.

[14] See for example, A. M, Adlerman and K. Y. Hao, 'The Initial Public Offering Process', in J. E. Riley and L. H. Simons, III (eds.), *How to Prepare an Initial Public Offering*, Practising Law Institute, New York, 1994, p. 389.

appreciation afterward). An additional disincentive to adjust the price upward significantly is the risk of receiving objection from the SEC. SEC gives green light based on the registration statement. The registration statement contains a preliminary prospectus in which the estimate range of offering price is stated. The final price has to be reported in the pricing amendment. If the SEC has objections to the amendment because there are substantive changes in the amendment, then all the confirmed sales is cancelled. The firm has to file a post-effective amendment, and the review process begins anew. This situation can be very costly in term of time and money, and very embarrassing for the firm and the underwriter. On the other edge, the underwriter also needs to protect its *reputation (in the issuing firms' point of view)* by not underpricing the issue. These two 'stabilizing' forces induce the underwriter to (i) price the IPO at Pa, the market-perceived true value, instead of Pb, the attainable temporary excess-demand-induced value, and (ii) not to price below Pa (not to underprice the issue).

4. The investors

Some researchers, using behavioral and psychological arguments, suggested that the positive initial return is an overreaction phenomenon. The word overreaction conveys an irrational decision making. Unlike the overreaction proponents, I use economic arguments and rationality assumption to explain the anomalies. I argue that the positive initial return is a natural consequence of rational investors who act properly conditioned on their information set (which consists of public and private information) at the time they make their decision. It is the differences in the information set (under which the investors react properly/rationally and hence not overreact) that leads to different valuation that - combined with the IPO mechanisms that cause deviations from perfect market conditions, and excess demand circumstances- leads to positive initial returns (improperly called 'underpricing').

At the first glance, the investors, who adopt a strategy to buy in the after-market, are irrational because they will lose money. There some problems with that statement. It assumes that (i) ALL investors know ex ante that if they buy shares in the immediate after-market, on average they will lose money, and (ii) the investors can adopt only a static buy and hold strategy. If there are some fractions of investors who do not have the knowledge in their information set (to have the knowledge in the information set is defined as to know and believe the knowledge) that the price in the immediate after-market on average higher than the market-perceived true value per share, then ex-ante, it is rational for them to buy shares in the immediate after-market if based on their valuation the price is cheap.

Also, recall that I assume the underwriter on average (not necessarily in all individual issues) set the price correctly. It is very possible that for a particular issue the underwriter's valuation is on the low side of the distribution. In that case, buying at a price slightly higher than the offering price may result in some profits. Therefore, although on average the investors will lose money if they adopt the static buy and hold strategy, when they adopt a slightly different strategy, for example a dynamic cut loss/capital preservation strategy, they can make money. In a dynamic cut loss strategy, investors get out if the

price goes down by a certain percentage point and ride the bull when the price appreciates.[15] This asymmetric option-like payoff makes the strategy suitable for buying high risk/volatile shares. IPO shares are more likely to face higher level of heterogeneity in valuations compared with the established/seasoned firms. This high level of heterogeneity in valuations translates into high risk/volatility because arrival of new information is relatively more intense surrounding IPO events. Some investors may choose to utilize the dynamic investment strategy on the IPO shares because the IPO firms have some new characteristics that are not possessed by the existing seasoned firms. These new characteristics are reflected in the price behavior of the firms' shares and act as market completers. They enable the investors to hedge some part of their future consumption variability/risk. Thus, (i) the option to adopt dynamic strategy explains how the investors can do better than the benchmark even if buy and hold strategy will on average underperform the benchmark, (ii) the market completion argument gives one reason for the investor to utilize the strategy on the IPO shares as opposed to the risky seasoned shares. The arguments, used together, can explain why it is rational for some investors to buy IPO shares in the immediate after-market.

Moreover, buy and hold strategy is only for investors with relatively long-term investment horizon. The underperformance of buy and hold strategy for investing in the IPO stocks is only significant if the shares are held for relatively long-term period. For some investors, who have short-term investment horizon (for example the speculators) for any given shares, the underperformance is not significant. For these short-term investors, decision to buy shares in the immediate after-market based on their information set is tenable and rational.

5. Long-term performance

Until now, it has been discussed that one implication of the model is that the immediate after-market equilibrium price is on average greater than the full information value and/or the market-perceived true value. This discrepancy will be corrected gradually as information is revealed over time. The question is how long will it take for the price to converge to the true value. To answer the question, let's make some comparison with the seasoned shares. From the literature on empirical evidence regarding mispriced securities, there are two widely cited empirical studies: DeBondt and Thaler (1985, 1987), and recently by Lakonishok, et al (1994). The empirical studies found evidence that are consistent with a hypothesis that overpriced shares gradually converge to their true values and the convergence process takes 3-5 years. The portfolio of the overpriced shares (the 'winner' portfolio in DeBondt and Thaler, and the 'glamour' portfolio in Lakonishok, et al) underperformed the benchmark after 3-5 years. Based on this figures, it is not very surprising for the (excess-demand-induced mispriced) IPO shares to converge gradually, in 3-5 years, to their true values.

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[15] One popular varian of this strategy is the 'buy high sell higher' strategy, where the investors invest in the firm with high growth potential and its price is appreciating. An example of this strategy is the C.A.N.S.L.I.M stock investment strategy popularized by Investor's Business Daily's William J. O'Neil (William J. O'Neil, 1995, *100 Ways to Improve Your Investment Results!*, Los Angeles: Investors Business Daily).

Furthermore, let's consider the following theoretical scenario. The demand at the offering date and the immediate after-market is generated based on N investors who are aware of the company and considered it to be included in their portfolio. After the company went public, more information is generated about the company. The information generation causes two things: (1) the distribution of valuations becomes more precise/less variations, (2) more investors become aware of the new company and start to consider it to be included in their portfolio, therefore N increases gradually. This gradual increase in demand will slow down the convergence process of the market price to the full information value. As fraction of investors who are aware of the company gets closer to 1, the speed of the arrival of the newly aware investors becomes slower. It will weaken the dampening effect of increase in demand. There are also other factors that eventually limit the dampening effect, for example, competition from existing seasoned shares as well as new IPO shares. The point is, there are factors that reduce the speed of convergence, but the factors eventually die down. As a result, the market price will converge to the full information value, and this convergence process takes some time.

III.2. Important assumptions

1. Information gathering and differences in individual information sets.

A1. Information is costly.

A piece of data will be categorized as information to an actor if the actor knows, understands and believes that it is correct/true. Gathering information is a costly activity (in term of the opportunity cost of time and the out of pocket expenditures).

A2. Investors have limited wealth for investment.

Investors will search for (private) information until the expected marginal revenue from additional information equals the marginal cost of acquiring the information. The results of the search vary from one investor to another, but one thing is the same: each investor can collect only limited amount of information, because information is costly and he has only limited wealth to spend. Consequently, each investor is facing a limited common information set (public information) and a limited individual specific information set (private information).

A3. There are many investors, but the number of investors is not infinity.

This, together with A1 and A2, implies even the market collectively can only collect limited amount of information (out of all possible information) about a particular firm at a point in time.

A4. Underwriter knows and believes the scenario of the model.

This assumption implies that an investor's valuation is the expected value conditional on his information set. In the section relaxation of assumptions, the effect of changing this assumption into risk aversion is discussed.

A5. Only a fraction of investors know and believe the scenario of the model.

The words 'scenario of the model' refer to: (i) underwriters do not underprice, and they on average prices IPO shares correctly, (ii) due to average excess demand and heterogeneous valuations by investors, equilibrium price in the immediate after-market is on average greater than the market-perceived true value per share. A4 and A5 implies that the knowledge of the scenario of the model is an integrated part of the underwriter's information set, while -as a part of heterogeneity of information- only a fraction of investors has this knowledge in their information set. It is realistic to assume that this knowledge is in the underwriter's information set. It can be defended by the fact that the underwriter is a long-term/permanent participant and an experienced player/expert in the IPO market (see also A11). In the meantime, only a fraction of investors (the IPO-experienced investors) participate regularly and hence can be assumed to also possess the knowledge in their information set.[16] The other investors are occasional/transitory participants in the IPO market, therefore their knowledge is limited. They do not know the peculiar characteristic of the IPO market.

2. Market efficiency and individual rationality.

A6. Investors are risk neutral.

A7. Investors are rational, they bid if the price is less than their valuations (based on the information sets facing them).

Conditioned on his/her unique information set, each investor rationally comes up with different valuation. The investor rationally makes his/her bid decision based on his/her valuation. The assumptions that each investor has only limited access to capital/funds and each the investor faces different information set and he/she acts rationally based on the information set, imply the demand curve will be downward sloping.

A8. On average, the market-perceived true value reflects the full information value.

Full information value of the firm is the value conditioned on all possible information at a particular time (Ψ_t). Market-perceived true value of the firm is the value conditioned on information set possessed/collected by the market as a whole at a particular time (Ω_t). A6 says that market *as a whole* on average price stocks correctly.

A9. Change in the full information value over time is random.[17]

This assumption, together with A13, implies that the full information value at t=0 is the best prediction (at that time) of the full information value over time.

A10. Underwriters, on average price the IPOs at the full information value.

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[16] Benveniste and Spindt (1989), Benveniste and Wilhelm (1990) argued that 'underpricing' is one mechanism for underwriter to compensate this permanent investors for revealing their information to the underwritier. For empirical evidence on the existence of investors that regularly participate in the IPOs, see Hanley and Wilhelm (1995).

[17] This assumption can be formalized as a Wiener process:

$d\mu(t) = a(\mu,t)\,dt + s(\mu,t)\,dZ(t)$, where $dZ(t) = \sqrt{dt}\,\tilde{u}$ and $\tilde{u} \sim N(0,1)$

The certain component $a(\mu,t)$ is assumed to be zero.

I assume that the firm/underwriter has done their homework properly such that the offered price is on average equal to the full information value per share.

A11. Underwriters are long-term players in the IPO market

This assumption is needed for explaining why the underwriter will be reluctant to price the IPO above what they believe to be the market-perceived true value.

A12. Short-selling is limited.

Although at the first glance this assumption seems too strong, it is not that unrealistic to impose this. In order to short-sell, one needs to 'borrow' shares (from a brokerage firm). The problem is, around t=0, the shares are still not available to be borrowed. Therefore, the during the first weeks after the offering date, short-selling is effectively limited, thus the short-selling 'constraint' is a non-binding one. Moreover, not many investors are comfortable to utilize this short selling. Even if the investors are risk neutral in their regular buying decisions, they will exhibit a risk aversion for short-selling decision. The asymmetry of the potential payoff of short-selling strategy (unlimited potential loss, and limited potential gain) and the limited wealth of the investors causes the investors to require (substantial) risk premium for using the short-selling strategy or even to the point of avoiding this very risky strategy because of the possibility of experiencing the '*gambler ruin problem*' phenomenon. The required risk premium for short-selling prevent the investors to short-sell shares whose market values are not substantially above the investors' private valuations. This 'truncation' causes short-sellings to be limited compared with the regular buying transactions.

Short-sellers are most likely to be parties who (i) are very confident with their private valuations, (ii) have above average credit rating, (ii) have large wealth (as a buffer against the gambler's ruin problem). Based on these characteristics, the most likely candidate for short-sellers are the institutional investors who frequently participate in the IPOs. However, these most likely candidates will not have a good incentive to short-sell because (i) they have built a good long-term relationship with the underwriters/investment bankers, (ii) the underwriters reward them by giving them priority in allocation of IPO shares (Hanley and Wilhelm[1995]), (iii) the underwriters, practicing price stabilization to prevent after-market price drop, will not be happy to see the institutional investors short-sell the IPO shares and will punish the short-sellers by excluding them from future allocation of IPO shares. The threat of being excluded from a relatively secured lucrative deals provide an economic disincentive to short-sell the IPO shares.

Note also that short selling strategy is on average unprofitable to be applied here. Although the long-term CAR (starting from the immediate after-market price equilibrium) is on average negative, the raw return is still on average positive. Short-selling strategy cannot make money if the price is non-decreasing function of time, which on average is the case for IPO shares.

3. Simplifying and miscellaneous assumptions

A13. Without loss of generality, the risk-free interest rate is assumed to be zero.

In term of the Wiener process (A9), the drift component is zero. Overtime, new information will arrive randomly and changes the full information value. But on average, the full information value at the time of price setting is the best prediction of the full information true value of the firm over time.

A14. Investors' wealth available for investment and is exogenously determined and is the same for all investors.

The purpose of this assumption is to concentrate on important features that affect the final result without having to complicate the process with unnecessarily difficult to manage math. Relaxation of this assumption will not likely to change the qualitative results (positive initial return, long-term underperformance, etc). Differences in individual valuation regarding the firm, rational decision based on the valuation, limited wealth, and same wealth across investors enable us to work with smooth demand distribution. Furthermore, if the distribution of investors' valuations is assumed to be normal/symmetric bell-shaped distribution, then the demand curve is of a rotated S shape.

A15. In the event of oversubscription, shares are allocated proportionally.

Under oversubscription circumstances, an investor will receive (S/D) times his/her initial demand. Or alternatively, it can be interpreted as each investor was randomly selected and has probability (S/D) of being chosen, and the chosen investor will get 100% of his/her original demand.

A16. $f_t(\tilde{v})$ does not change between t=T2 to t=0.

For the base case scenario, the unconditional distribution of value per share is assumed to be the same at T2 (the time the underwriter announces the preliminary offering price) as at the offering date. This assumption will be relaxed later when analyzing the partial adjustment phenomenon.

III.3. Variables and the Decision Making Process

1. Information sets and density functions

Subscript t refers to time-t, subscript i refers to investor-i.
Time t=0 refers to the offering time.
Market

Π_t = Set of collected public information at time t, such as: the preliminary prospectus, underwriter reputation, age of firm, etc.

ϕ_{it} = Set of private information collected by investor-i at time t

ϕ_t = Set of all private information collected by the market as a whole at time t
$= \bigcup_{i=1}^{N} \phi_{it}$

Ω_t = $\{\Pi_t, \phi_t\}$ = Set of all (public + private) information collected by the market as a whole at time t

$\Omega_t \subset \Psi_t$

Ψ_t = Set of all possible information at time t $\equiv (\Omega_t, \bar{\Omega}_t)$

(See Figure 3)

$\tilde{v}$ = Per share value of the risky asset, $\sim f_t(\tilde{v})$,

$f_t(\tilde{v})$ = The unconditional distribution of $\tilde{v}$ at time t.

$E_t(\tilde{v}) = \mu_t, \quad Var_t(\tilde{v}) = \sigma_t^2$

$E(\tilde{v}|\Omega_t) = \bar{v}_{\Omega t} = \sum_{j=1}^{Mt} v_j / Mt$ =Market-perceived true value at time t

$E(\tilde{\bar{v}}_{\Omega t}) = \mu_t$ and $Var(\tilde{\bar{v}}_{\Omega t}) = \sigma_t^2 / Mt$

Mt = total number of data points or 'random samples' accumulated by the market as a whole until time t.

$E(\tilde{v}|\Psi_t) = \mu_t$ = Full information value at time t.

Note that if all possible information is collected by the market, then the market-perceived true value is exactly the same as the full information value, i.e.,

as Mt --> ~ , Ω_t --> Ψ_t , and $Var(\tilde{\bar{v}}_{\Omega t})$ --> 0.

Underwriter

Ω_{ut} = Underwriter's information set at time-t.

The process of information gathering by the underwriter is abstracted as if the underwriter collects m random samples from the unconditional $f_t(\tilde{v})$ density, and summarizes the information in term of a simple average of the samples = $\bar{v}_u$ which will become an official offering price (Po) if the IPO is not withdrawn. The distribution of $\tilde{\bar{v}}_u$ has mean μ_t, and variance σ_t^2/m. For the base case scenario, it is assumed that at the time (t) underwriter announces $\bar{v}_u$, $f_t(\tilde{v}) = f_0(\tilde{v})$ (i.e., $\Psi_t = \Psi_0$).

Investors

N = Number of investors.

$\Omega_{it} \equiv \{\Pi_t , \phi_{it}\}$ = Investor-i's information set at time-t

$\mu_{it} = E(\tilde{v}|\Omega_{it})$

Individually, each investor-i is assumed to collect n ($1 < n << m$) random samples from the $f(\tilde{v})$ density, and summarizes the information in term of a simple average of the samples = $\bar{v}_i$. The distribution of $\tilde{\bar{v}}_i$ has mean μ_0, and variance σ_0^2/n

In forming their final estimate of the value per share at t=0, some investors put a heavy weight on the valuation of underwriter ($\bar{v}_u$), while other investors put insignificant weight

on $\bar{v}_u$. At around t=0, the final investor-i's valuation becomes a weighted average of the valuation based on his (private) information, $\bar{v}_i$, and the underwriter's valuation, $\bar{v}_u$:

$$\bar{v}_{wi} = k_i \ \bar{v}_u + (1-k_i)\ \bar{v}_i \qquad \text{where } 0 \le k_i \le 1$$

thus, the distribution of $\tilde{\bar{v}}_{wi}$ has a mean μ_0, and a variance $\sigma_0^2[k_i^2\ (1/m + 1/n) - 2k_i + 1]$. As an abstraction of heterogeneity in investors' confidence in the underwriter's valuation, the weight ki varies among investors.

k_i = $k\ (\mathbf{y}_i)$

y = vector of independent variables that affect k. For example:

(i) Belief about the scenario of the model. Investors who believe in the underpricing based scenario (in which the underwriter underprices the IPO shares and the immediate after-market price reflects the market-perceived true value) will put insignificant weight on $\bar{v}_u$. On the other hand, investors who believe that the underwriter on average price the IPO shares correctly and the immediate after-market price is bid up by average excess demand, will put substantial weight on $\bar{v}_u$.

(ii) Type of investors -long-term investors vs short-term speculators. The speculators are more likely to put larger weight on his own valuation $\bar{v}_i$.

Note that $\sigma_0^2[k_i^2\ (1/m + 1/n) - 2\ k_i + 1]$ is a decreasing function of k_i. Thus the degree of heterogeneity in valuations is higher among investors with low k.[18]

μ_{io} = $\bar{v}_{wi}$

The μ_{io}'s make up the $g_o(\cdot)$ density function,

$g_o(.)$ = Distribution (density function) of individual valuations at t=0;
this distribution is important in forming the market demand function

$$= \sum_{i=1}^{N} \text{density function of } \tilde{\bar{v}}_{wi} \ / \ N$$

Thus, $g_o(\cdot)$ has mean = μ_0 and variance = $\sum_{i=1}^{N} \text{Var}(\tilde{\bar{v}}_{wi}) \ / \ N$.[19]

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[18] $\text{Var}(\bar{v}_{wi}(k_i)) = \sigma_0^2[\ k_i^2\ (1/m + 1/n) - 2\ k_i + 1]$.

$d\text{Var}(\bar{v}_{wi}(k_i))/dk_i = 2\ \sigma_0^2[\ k_i\ (1/m + 1/n) - 1] \ < 0$ for $0 < k_i < 1$ and $m >> n > 1$

[19] If g(x), h(x) are density functions with variance Var_g and Var_h, and with the same mean μ, and $f(x) = c1\ g(x) + c2\ h(x)$, c1, c2 constant $0<c1<1$, $0<c2<1$, $c1+c2=1$, then based on f(.),

$$E(X) = \int x\ f(x)\ dx = c1 \int x\ g(x)\ dx + c2 \int x\ h(x)\ dx = c1\ \mu + c2\ \mu = \mu$$

$$E(X-\mu)^2 = c1 \int (x-\mu)^2\ g(x)\ dx + c2 \int (x-\mu)^2\ h(x)\ dx = c1\ \text{Var}_g + c2\ \text{Var}_h$$

In $g_o(\cdot)$, $c_j = 1/N$ for all j.

Investors as a whole, on average value the shares correctly.

2. Supply, individual and market demand

It has been assumed that the firm/underwriters have done their homeworks properly such that the offered price (P_0) is on average equal to μ_0 (i.e., $E(\tilde{v}|\Psi_0)$), the full information value per share at t=0.

Based on the rationality and risk neutrality assumptions, for investor i, the individual demand function is:

$$D_{it}(P) = \begin{cases} W, & \text{IF } P \leq \mu_{it} \\ 0, & \text{IF } P > \mu_{it} \end{cases}$$

where W is the wealth available for investment and is assumed to be exogenously determined and is the same for all investors.

Market demand function is a result of a cumulative summation of the individual demand function:[20]
(See Figure 4)

$$D_t(P) = NW \int_P^{P_t^{max}} g_t(\mu_{it})\, d\mu_{it},$$

P_t^{max} = Maximum price within the domain of $g_t(.)$
S = Total supply of the risky asset

(See Figure 5)

Excess demand function consists of a random (error) component and a systematic (error). It is assumed that if Po is set exactly at the full information value μ_0, then the market demand is on average equal to the supply. At $Po = \mu_0$, excess demand occurs because of the random component (the noise). The noise is caused by (aggregate) sampling error by investors as a whole. When Po is not equal to μ_0, in addition to the random error, there is a systematic error component.

$$D_0(\mu_0) = \Delta_0(\mu_0) + \varepsilon(\Omega_0,\mu_0) = S + \varepsilon(\Omega_0,\mu_0)$$

$$D_0(\bar{v}_u) = D_0(\mu_0) + \tau(\bar{v}_u,\mu_0,\Omega_0) = S + \varepsilon(\Omega_0,\mu_0) + \tau(\bar{v}_u,\mu_0,\Omega_0)$$

$$\Leftrightarrow \quad D_0(\bar{v}_u) - S = \varepsilon(\Omega_0,\mu_0) + \tau(\bar{v}_u,\mu_0,\Omega_0)$$

$\Delta_0(.)$ = The intrinsic demand function, i.e., the demand if the random component is zero, and therefore demand equals supply.

[20] If μ_{it} is not a continuous variable, the integral becomes summation, but the main results stay the same

$\varepsilon(.,.)$ = The random component, due to sampling error by investors/the market as a whole.

$\tau(.,.,.)$ = The systematic component, due to sampling error by the underwriter, and the difference between, underwriter's sampling error and investors' sampling error.

3. Summary of the process

Time	**----------T1----------T2-----T3-0-0^{+}----------**
STEP	**1, 2, 3, 4,5, 6, 7,8, 9**

T1 = approximately 2-4 months before the offering date.
T2 = approximately 1-1.5 month before the offering date.
T3 = approximately 1-2 days before the offering date.

STEP 1. Firm has a project that needs capital, and has decided to raise capital through IPO. Based on NPV and potential dilution consideration, it has been determined that the minimum required capital to be raised is C_{min}, the maximum number of shares to be issued is Q, and the minimum acceptable price is $P_{floor} = C_{min}/Q$. The unconditional density at time-t of the firm's value per share is $f_t(\tilde{v})$, with mean μ_t and variance σ_t^2

STEP 2. At t = T1 to T2, the underwriter collects information about firm's value. The information collection will be abstracted as if the underwriter takes a random sample of size m out of the density $f(\tilde{v})$. The underwriter gets $v_{u1}, v_{u2},...,v_{um}$, and summarizes the information:

$$\bar{v}_u = \sum_{j=1}^{m} v_{uj}$$

If $f_t(.)$ is $N(\mu_t, \sigma_t^2)$ then $\tilde{\bar{v}}_u \sim N(\mu_t, \sigma_t^2/m)$.

Thus, the underwriter on average prices the IPOs correctly at μ_t. It is assumed that between t=T2 and t=0 there is not any change in Ψ_t, $f_t(.)$, and hence no change in μ_t.

STEP 3. At t=T2, the underwriter announce $\bar{v}_u$

STEP4. Investors observe $\bar{v}_u$. Each investor-i. collects information about firm's value. The information collection will be abstracted as if the investor takes a random sample of size n out of the density $f(\tilde{v})$. The investor-i gets $v_{i1}, v_{i2},...,v_{in}$, and summarizes the information,

$$\bar{v}_i = \sum_{j=1}^{n} v_{ij}$$

If f(.) is $N(\mu_t, \sigma_t^2)$ then $\tilde{\bar{v}}_i \sim N(\mu_t, \sigma_t^2/n)$.

The final investor's valuation takes into account $\bar{v}_i$ and $\bar{v}_u$. Therefore $g_O(.)$ -the density of investors' valuations- can be regarded as a distribution of sample mean statistic. Thus, each investor, and investors as a group, on average come up with the correct valuation μ_t.

STEP 5. Between T2 and T3, underwriter collects indications of interest from investors, based on the announced price $\bar{v}_u$.

STEP 6. Excess demand consists of a random component (the noise), and a systematic component (the signal). Using some projection/signal extraction techniques, the underwriter estimates the systematic component, the full information value, the random component and the market-perceived true value.

a. IF the random component is significantly negative, and thus the estimated total demand at the new estimate of μ_0 is significantly less than S, THEN the offer is withdrawn. Otherwise the new price estimate becomes the official offering price Po.

b. IF the random component is positive, and thus estimated total demand is greater than S THEN the shares are allocated proportionally to investors based on their initial demand.

STEP 7. Based on the final offer price Po and their final valuations (which already took into account $\bar{v}_i$, $\bar{v}_u$, and Po) investors make their buying decisions.

STEP 8. In the immediate after-market ($t=0^+$), investors are free to buy and sell the shares. New equilibrium is achieved at price = P* that equates S and D.

STEP 9. Uncollected information is gradually revealed. As the information is gradually revealed, the level of the heterogeneity of information is reduced. In the long run, the market price will converge to the full information value.

III.4. After-market Equilibrium

Proposition 1. Positive initial return ('underpricing').
The (temporary) equilibrium price (P*) in the immediate after-market is higher than the offering price. A positive initial return is observed.

Proof:

In the previous section, it has been argued that on average there will be an excess demand. In the after-market, investors that -based on their information set- value the firms highly and did not get initial allocation will bid the price up until a new equilibrium is achieved. The new equilibrium price P* is such that total amount that the existing shareholders are willing to sell at P* = total amount that investors are willing to buy at P*.

(See Figure 6 and Figure 7)

$$N\ W\ \ b\int_{P_0}^{P^*} g_0(\mu_{i0})\, d\mu_{i0} = N\ W\ (1-b)\int_{P^*}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}$$

(b = Probability of getting allocation = $\min\{\frac{S}{D_0(P_0)}, 1\}$)

$$<=> \quad b\{\int_{P_0}^{P^*} g_0(\mu_{i0})\, d\mu_{i0} + \int_{P^*}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}\} = \int_{P^*}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}$$

$$<=> \quad b \int_{P_0}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0} = \int_{P^*}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0} \quad <=> \quad b = \frac{\int_{P^*}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}}{\int_{P_0}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}}$$

Note that $g_t(.) \geq 0$ and $0 \leq b \leq 1$. Therefore,

$$0 \leq \frac{\int_{P^*}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}}{\int_{P_0}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}} \leq 1 \quad <=> \quad 0 \leq \int_{P^*}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0} \leq \int_{P_0}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}$$

$$=> \quad P_0 \leq P^* \leq P_0^{max} \qquad \square$$

The main driving forces used in the proof are the fact that there is an average excess demand and in the after-market, investors are free to buy and sell, and therefore in equilibrium the shares will be owned by a subset of investors who value the shares higher than the rest of the pool. Proposition 1 says that in the after-market, price will jump from P_0 to P* even without arrival of any new information or without any change in the full information value. Note that the positive initial return is not a result of a deliberate action of the underwriter to underprice the issue (in the sense that the underwriter set the price below the value according to underwriter's valuation, or $P_0 < \mu_0$). It is a logical consequence of excess demand and quantity rationing in the initial distribution of the new issue.

The following corollary gives the relation between excess demand and initial return. A higher excess demand can be pictured as: (1) lower supply for a given demand distribution, or (2) Larger D(Po) for a given supply. Both cases can be represented as a lower b. Therefore to check the relation between excess demand and the initial return, we just need to check the relation between b and P*, keeping other variables constant.

Corollary 1.1. Initial return and excess demand
The higher (the lower) the excess demand, the higher (the lower) is the initial return.

Proof:
From proposition 1,

$$b = \frac{\int_{P_0}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}}{\int_{P_0}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}}, \quad P^*$$

$$\Rightarrow \frac{db}{dP^*} = \frac{-\, g_0(P^*)}{\int_{P_0}^{P_0^{max}} g_0(\mu_{i0})\, d\mu_{i0}} < 0, \text{ because } g_0(.) \geq 0 \text{ and } P_0 < P_0^{max} \quad \square$$

Corollary 1.1 says that keeping other variables constant, there is a negative relation between b and P*. The lower the b (the higher the excess demand), the higher the P*, Because other variables including Po have been kept constant, a higher P* implies a higher initial return.

Corollary 1.2. Long-term underperformance.
In the long run, IPO stocks on average will underperform the market.

Proof:
For IPO shares (t = 0, is the offering date for the IPO shares), by proposition 1 at $t = 0^+$, $P_t = P^* > Po$, and by market efficiency assumption,

$E(Po) = \mu_0$, $E(\mu_t) = \mu_0$, and $\lim_{t \to \infty} (P_t - \mu_t) = 0$.

For the market benchmark (marked by subscript B), that consists of seasoned stocks, by market efficiency,

$P_{Bt} - \mu_{Bt} \simeq 0$ both at t = 0 and t = T

IPO shares	Benchmark
(i) $P^* - \mu_0 > 0$	$P_{B0} - \mu_{B0} \simeq 0$
(ii) $P_T - \mu_T \simeq 0$ for large T	$P_{BT} - \mu_{BT} \simeq 0$
(iii) $\mu_T \simeq \mu_0$	$\mu_{BT} \simeq \mu_{B0}$

$\therefore \quad P_T - P^* \lesssim P_{BT} - P_{B0} \simeq 0$ $\square$

The intuition of Corollary 1.2 is as follows. It has been assumed that, in the long run price will reflect the fundamentals. Overtime, the optimistic investors (investors who get favorable private information subset) learn the market-perceived true value of the share. As a result, the price will converge to the market-perceived true value per share. From proposition 1, the market-perceived true value per share is on average less than the immediate after-market price. Also recall that it has been assumed that P_0 on average matches μ_0 and hence it is the best prediction at t=0 of the future value per share of the stock. Therefore, even if there is not any new negative shocks/information, on average in

the long run the IPO stock will underperform the market benchmark/seasoned stocks in the same risk category.

IPO initial return varies from firm to firm. The following proposition (proposition 2) is an important starting point to investigate the variation in the initial return. It says that the flatter tail of the $g_t(\mu_{it})$ implies the position of P* is shifted to the right. Therefore the difference between P_0 and P*, i.e., the initial return, becomes larger.
(See figure 8)

Proposition 2: Density tail and initial return
The thicker is the tail of the g(.), the larger is the positive initial return.

Proof:
To shorten the notations, without loss of generality, we will normalize N W = 1 (so that the density function is the demand function). We will compare two density functions (previously we used g(.) as a name of the demand density function, but for this proof other names will be used), one with a thicker tail -call it h(.)- and the other with a thinner tail -call it k(.).

To make a fair comparison, we need three things:
(i) equality of means of both density functions (at P_0)
(ii) equality of the maximum valuations under both density functions, i.e.,
$P_0^{h\max} = P_0^{k\max} = P_0^{\max}$
(iii) equality of $D(P_0)$ given h(.) and $D(P_0)$ given k(.), i.e.,

$$D^h(P_0) = \int_{P_0}^{P_0^{\max}} h_0(\mu_{i0})\, d\mu_{i0} = \int_{P_0}^{P_0^{\max}} k_0(\mu_{i0})\, d\mu_{i0} = D^k(P_0) \qquad .....(1)$$

To save place, we will suspend the subscript for h(.), k(.), and μ.
Because of (1) and because h(.) has a thicker tail than k(.),
$\exists$ x* in interval $(P_0 ; P_0^{\max})$ ϶ $h(\mu) > k(\mu)$ for $\mu > x^*$, and $h(\mu) < k(\mu)$ for $\mu < x^*$
(see Figure 9).
Suppose under k(.) and h(.), the after-market equilibrium is achieved at P^{*k} and P^{*h}. Thus,

$$D^k(P^{*k}) = \int_{P^{*k}}^{P_0^{\max}} k(\mu)\, d\mu = S = \int_{P^{*h}}^{P_0^{\max}} h(\mu)\, d\mu = D^h(P^{*h}) \qquad .....(2)$$

and by equation (1) and (2),

$$D^k(P_0) - S = \int_{P_0}^{P^{*k}} k(\mu)\, d\mu = \int_{P_0}^{P^{*h}} h(\mu)\, d\mu = D^h(P_0) - S \qquad .....(3)$$

We want to show that at the equilibrium, $P^{*k} < P^{*h}$.

We will check two possibilities: Case 1. $P^{*k} > x^*$, case 2. $P^{*k} < x^*$

Case 1. $P^{*k} > x^*$

Recall we have assumed that $k(\mu) < h(\mu)$ for $\mu > x^*$.

Now there are three possibilities, $P = P^{*k}$, $P < P^{*k}$, or $P > P^{*k}$

(1) IF $P = P^{*k}$

$$\text{THEN } D^h(P) = \int_{P^{*k}}^{P_0^{max}} h(\mu)\, d\mu > \int_{P^{*k}}^{P_0^{max}} k(\mu)\, d\mu = S$$

Therefore P^{*k} can not be an equilibrium price under h(.)

(2) IF $P < P^{*k}$

$$\text{THEN } D^h(P) = \int_{P}^{P^{*k}} h(\mu)\, d\mu + \int_{P^{*k}}^{P_0^{max}} h(\mu)\, d\mu > S$$

Therefore any $P < P^{*k}$ can not be an equilibrium price under h(.)

(3) IF $P > P^{*k}$

$$\text{we know that } \int_{P^{*k}}^{P_0^{max}} h(\mu)\, d\mu > S > \int_{P_0^{max}}^{P_0^{max}} h(\mu)\, d\mu = 0$$

By continuity and intermediate value,

$$\exists\ P \text{ in } (P^{*k}, P_0^{max}) \ni \int_{P}^{P_0^{max}} h(\mu)\, d\mu = S \quad \text{(equilibrium under h(.)).}$$

This P is the equilibrium price under h (i.e., P^{*h}).

Therefore $P^{*h} > P^{*k}$

Case 2. $P^{*k} < x^*$

Recall we have assumed that $k(\mu) > h(\mu)$ for $\mu < x^*$.

Now there are three possibilities, $P = P^{*k}$, $P < P^{*k}$, or $P > P^{*k}$

(1) IF $P = P^{*k}$

THEN $D^k(P_0) - S = \int_{P_0}^{P^{*k}} k(\mu)\, d\mu > \int_{P_0}^{P^{*k}} h(\mu)\, d\mu$

Therefore, by equation (3), P^{*k} can not be an equilibrium price under h(.)

(2) IF $P < P^{*k}$

THEN $D^k(P_0) - S = \int_{P_0}^{P^{*k}} k(\mu)\, d\mu > \int_{P_0}^{P^{*k}} h(\mu)\, d\mu - \int_{P}^{P^{*k}} h(\mu)\, d\mu = \int_{P_0}^{P} h(\mu)\, d\mu$

Therefore any $P < P^{*k}$ can not be an equilibrium price under h(.)

(3) IF $P > P^{*k}$

we know that $\int_{P_0}^{P^{*k}} h(\mu)\, d\mu < D^h(P_0) - S < D^h(P_0) = \int_{P_0}^{P_0^{max}} h(\mu)\, d\mu$

By continuity and intermediate value,

$\exists$ P in (P^{*k}, P_0^{max}) $\ni$ $\int_{P_0}^{P} h(\mu)\, d\mu = D^h(P_0) - S$ (equilibrium under h(.)).

This P is the equilibrium price under h (i.e., P^{*h}).

Therefore $P^{*h} > P^{*k}$.

That completes the proof □

Although Proposition 2 requires relatively long algebra manipulations, the intuition is simple. Other things being equal, if the density has a thicker tail, then a larger portion of investors value the shares highly. As a result, the immediate after-market price will be bid higher. This is obvious for the case 1, where $P^{*k} > x^*$, because always $h(\mu) > k(\mu)$ for $\mu > x^*$. But for case 2, it is not obvious because $h(\mu) < k(\mu)$ for $\mu < x^*$. For case 2, the trick is to work with excess demand instead of demand.

Corollary 2.1. Heterogeneity in valuations and initial return
The higher the degree of heterogeneity in valuations surrounding the shares of the IPO firm, the higher is the initial return

Proof:
Higher heterogeneity in valuations is caused by more diverse information sets facing individual that leads to greater variation in individual valuation. Other things kept fixed, greater variation will be reflected in a thicker tail distribution of initial valuations by investors, then it follows from proposition 2 that, higher degree of heterogeneity in valuations implies higher initial return. □

Corollary 2.1. can also be regarded as a relation between risk and return. The terminology risk here is risk in general sense (variation in the distribution), but it is slightly different to the terminology risk used in the asset pricing literature. In the latter field, risk is defined as volatility of price change over time.

Some researchers have suggested certification as a factor that affects the variation in the initial IPO return (see for example Booth and Smith [1986]). They argue that if there exist some credible/qualified long term players that get involved in an IPO, the level of initial return of the IPO will be closer to zero. The higher the quality/reputation of the certifier, the closer to zero will be the level of the initial return. Some long term players as certifiers have been suggested: auditor (Titman and Trueman [1986]), investment banker (Carter and Manaster [1990]), commercial banker (Slovin and Young [1990]), venture capitalist (Barry, et al [1990], Megginson and Weiss [1991]), NYSE, AMEX, NASDAQ-NMS (Afflect-Graves, et al [1993]).

Corollary 2.2. Initial return and certification
The higher is the quality of the certifier, the lower is the initial return.

Proof:
Investors will take into account information about quality of underwriter/auditor in forming their private valuation. The higher the quality of the underwriter, the more confidence/weight the investors put on the price set by the underwriter, therefore the distribution of valuation will be more concentrated around that price. It means that the demand distribution has a thinner tail. By proposition 2, the bid in the after market will be closer to the initial price. □

III.5. Implications on other Related Documented Empirical Evidence

1. Hot issue markets

The hot and cold cycle phenomenon can also be understood using the model. When there are positive exogenous shocks to the market or a particular sector of the market, the distribution of valuation changes. A greater proportion of investors receives favorable information and become optimistic about the potential of the to-go-public firms. In the meantime, underwriters who do not want to jeopardize their reputation will set the initial price at the market-perceived true value per share. This results in a higher than average initial returns. The positive shock/new information, works like a positive multiplier to the original random variable, or can also a combination of shift and multiplier (i.e., $\tilde{v}_{new} = c + d\ \tilde{v}_{old}$, where $c > 0$ and $d > 1$) resulting in higher mean and variance[21] . It implies a thicker tail distribution which -by proposition 2- translates into a higher initial return.

[21] $E(\tilde{v}_{new}) = c + d\ E(\tilde{v}_{old}) > E(\tilde{v}_{old})$, and $Var(\tilde{v}_{new}) = d^2\ Var(\tilde{v}_{old}) > Var(\tilde{v}_{old})$

Alternatively, allowing variation across individual in the wealth available for investment (W_i), during the hot issue period, optimistic investors are in command of larger pool of funds available for new investment. As a result, the degree of 'underpricing' is more severe.

Relation between excess demand and hot/cold issue markets can be analyzed as follows. According to the logic of the model, the larger is the excess demand, the higher is the positive initial return. Unconditional (inter-temporal/over time periods) distribution of excess demand has been assumed to have zero mean. Most of the realizations of positive excess demand occurs during the hot issue markets, most realizations of the excess supply (negative excess demand) occurs during the cold markets. Therefore the model predict that, keeping other factors constant, the fraction of fail IPOs (IPOs with extreme excess supply) is larger/smaller during the cold/hot issue periods.

2. *Partial adjustment phenomenon*.

Issues that have final offer prices which exceed the limits of the offer range (disclosed in the preliminary prospectus) have greater initial return than all other IPO and are also more likely to increase the number of shares issued (Hanley [1993]). Benveniste and Spindt (1989) predict that the initial return is positively related to revisions in the offer price from the filing of the preliminary prospectus to offer date; the final offer price only partially adjusts to new information.

This finding is in line with the reasoning behind my model. The final offer price in my model already incorporate all information gathered by underwriter during the preliminary period. Following the reasoning of my model, a positive shock/new information, that may arrive between the period of preliminary marketing and the time the final offer is set, works like a positive multiplier to the original random variable, or can also a combination of shift and multiplier, resulting in higher mean and variance. It implies a thicker tail distribution which translates into a higher initial return. The higher mean causes an upward adjustment, the higher variance/thicker tail causes a higher initial return (even after the initial price is adjusted to the new mean). Thus, although the underwriter already adjusts properly, it looks as if the price is only partially adjusted.

Alternatively, still in line with my model, it can be explained using a Bayesian updating argument. Underwriter has a prior estimate/knowledge about the market-perceived true value of the firm. The underwriter uses this prior to set the range of offering price in the preliminary prospectus. When the underwriter learn that the excess demand is large, the underwriter is more likely to update his valuation. Bayesian updating uses both the prior knowledge and the new information. It works like weighted averaging the prior and the new information. The final result is somewhere between the prior mean and the new information mean. Based on the Bayesian updating process, the more confident the underwriter with his prior valuation, the 'less fully' the price adjusts. In any case, it will be

observed as a partial adjustment phenomenon. Appendix 2 gives an example of a Bayesian updating process.

3. IPO volume and the hot/cold market cycle

The period of high IPO volume tends to follow hot issue period (Ritter [1984]). Using my model, it can be explain as follows: the issuers try to time the offering when there are plenty of optimistic investors in the market to reduce probability of failure. Price is still set on average at the market-perceived true value. When firms see a hot issue period, they know that there are plenty of optimistic investors in the market, and the market is characterized by excess demand. Thus, they will launch their IPO because the probability of failure is relatively low. Over time, the flow of these IPOs will reduce the aggregate excess demand and hence reduce the average initial return. As a result, the market cools down.

III.6. Other Predictions of the Model

1. Institutional investors.

By relaxing the simplifying assumption of equal wealth to be invested, we can analyze the role of (informed) institutional investors. If we are willing to assume that institutional investors (who possess larger amount of wealth (W)) are more informed, then my model implies the larger participation of institutional investors in the IPO, the more concentrated to the center is the demand distribution (Wi x g_0). Therefore the demand distribution has a thinner tail, and consequently, it implies lower initial return.

2. Over-allotment option

Over-allotment option is an option to sell extra share at the initial market. Exercising this option caused an increase in the supply S and therefore will increase b. This will reduce the excess demand. Selling more stocks at the preset price after knowing the existence of excess demand will reduce the price increase at the after-market. It implies a lower initial return. In addition, selling more stocks when the total full information value of firms stays the same will cause the full information value per share of the stock decline (dilution effect). However, the over-allotment option is more likely to be exercised when the potential initial return is very high.

Therefore the exercise of the option has several effects: (1) *Supply effect*: reduce the excess demand, (2) *Dilution effect*: shift the distribution of valuation to the left, (3) *Situational effect*: it is more likely to be exercised when the excess demand, and hence the potential initial return, is relatively high. On one hand, the exercise of the option will cause a lower initial return (compared with if it is not exercised). On the other hand, it is more likely to be exercised when the potential initial return is very high in the first place. Therefore without additional reason and/or assumption we can not tell whether IPOs without exercise of over-allotment option will have lower or higher initial return than IPOs

with exercise of the option. Note that the negative effect is weakened by limitation of overallotment option. The maximum number of extra shares that can be sold is limited (to about 10% of the IPO). For large excess demand situation, this limitation may significantly dampen the negative effect, and therefore the positive effect dominates the negative effect. My conjecture is IPOs in which the option is exercised will on average experience higher initial return.

III.7. Relaxing some Assumptions

Relaxation of assumption A1-A3, A5 moves the model toward a perfect world without uncertainty. Under this ideal world, there is not any heterogeneity in information and the main engine of the previous model breaks down. Therefore these assumptions are very crucial to the model. However, these assumptions are more realistic than the ideal perfect world.

Assumption A12 (short-selling is limited) has been discussed in the assumption section. This assumption turns out to be crucial to get the results. Without short-selling limitation, the price in the immediate after-market will not be higher than the Po. In the assumption section, the institutional reason for limited short-selling has been given. In addition, as long as investors still prefer regular buying transactions compared to short-selling, the immediate after-market price will on average be higher than Po.

Assumption A16 (no arrival of new information between T2 and 0) has been relaxed and discussed under section partial adjustment phenomenon. Assumption A14 (Wi = W for all i) has been analyzed in section institutional investors. Relaxing these assumptions does not change the qualitative results of the model.

The risk neutrality assumption is needed so that the individual valuation can be abstracted in much simpler mathematical notations. If we assume risk aversion, then the distribution of valuations should be corrected for some risk premium. And the final individual valuation can be formulated as,

$$\bar{v}_{i,\text{risk averse}} = \bar{v}_{i,\text{risk neutral}} - \text{Premium}(\sigma_t^2)$$

Using this formulation, the distribution of valuation is shifted to the left. Based on this new distribution, we still have heterogeneity in valuations, therefore the qualitative prediction of the model will follow through.

The proportional allocation assumption can be relaxed without changing the qualitative results. This assumption is made to make it mathematically easier to prove the propositions. Changing this assumption will not change the intuition of the proof which can be directly seen based on Figure 6 and 7. When the allocation is not proportional, the shaded areas in Figure 6 and 7 are not as neat (geometrically proportional) as it is pictured in these Figures. However, as long as there are heterogeneity in valuations and average excess demand, the equilibrium immediate after-market price P* is greater than Po.

In proving the propositions, I have implicitly assumed a nicely behave symmetric distribution of valuations. Again this assumption is only to make the proof mathematically less messier and easier to follow. The intuition of the proofs, as can be seen in Figure 6 and 7, is not affected by the shape of the distribution. As long as there are heterogeneity in valuations, average excess demand if price is set at Po which is on average equals μ_0, P* will be greater than Po.

III.8. Direct Tests for the Model

Proposition 1 gives the positive average initial return result. This result is driven by (1) the average excess demand, and (2) the uncertainty or heterogeneity of information/variation in the distribution of investors' valuations. Variation in the initial return is affected by (1) the level of excess demand (+), and (2) the level of the heterogeneity of information among investors.

One possible way to directly test the model is by separating the IPOs with and without excess demand and compare the average initial returns of the two groups. The model predicts that the IPOs with excess demand will experience positive average initial returns, while those with excess supply will experience negative initial returns. Furthermore, the number of successful IPOs with excess demand should exceed the number of successful IPOs without excess demand. One good proxy for excess demand is the level of oversubscription. Another good proxy is the volume of trade in the immediate after-market. The larger the excess demand, the lower the b, the larger the total shares bought and sold in the immediate after-market. Figure 7 gives an illustration of this process.

H1: IPOs with excess demand have positive average initial return.

H2: The number of IPOs with excess demand is greater than the number of IPOs with excess supply.

Next, based on the empirical evidence, during hot issue periods the average initial return of IPOs is relatively higher than the average initial return during other periods. Following the reasoning of my model, the relatively higher return must be caused by, (1) larger than average excess demand, and/or (2) higher than average uncertainty/variability in investors' valuations.

H3: Hot issue periods are characterized by above average excess demand, and/or above average uncertainty in investors' valuations on the IPO shares.

Based on the argument in section III.5.1, the following hypothesis is proposed.

H4: Fraction of withdrawn IPOs is smaller (larger) during the hot (cold) issue periods.

It is well documented that best efforts IPOs have higher average initial return compared with the firm commitment IPOs (Ritter [1987]). Therefore, my model predicts that on

average, (successful) best efforts IPOs are characterized with higher excess demand in the initial market, and/or higher uncertainty/variability in investors' valuations.

H5: Best efforts (firm commitment) IPOs are characterized with higher (lower) excess demand, and/or higher (lower) uncertainty in investors' valuations.

Corollary 1.2 establishes that because the immediate after-market equilibrium price is on average higher than the full information value, and market price will converge to the full information value, in the long run IPO shares on average underperform the benchmark (market) portfolio. In relation to H1, H3, and H5, the following hypotheses are suggested.

H6: IPOs with excess demand have more negative long-term abnormal performance

H7: IPOs during hot (cold) issue periods have more (less) negative long-term abnormal performance

H8: Best efforts (firm commitment) IPOs have worse (better) long-term abnormal performance.

III.9. Comparative Tests: The Model Vs other Existing Models/Theories

For comparison, other IPO models are categorized into three groups: (1) Price support, (2) underpricing, and (3) overreaction. For a brief review of these models see section II.2. General features of the models are summarized in figure 10.

1. Vs Price support/stabilization.

Among the existing explanations of IPO anomalies, the price support explanation is relatively the most appealing one. It is relatively simple, and does not assume underpricing and also does not assume individual irrationality.

Comparing my model and price support explanation, there are neat ways to test them.
(1) My model predict that in the long run, the positive initial return will on average be erased in the after-market. The price support hypothesis predicts that IPOs that experience positive initial return will not underperform the market, while IPOs with zero initial return will on average underperform the market.

(2) Excluding IPO with zero return, my model predict a negative relation between the initial return and the long-term performance, while the price support predict no relation between initial return and long-term performance.

(3) My model implies a positive relation between excess demand and initial return, and a negative relation between excess demand and long-term performance. Price support does not predict any relation between excess demand, initial return and long-term performance.

2. Vs underpricing-based models

The main differences between my model an the underpricing-based model are:
(1) In my model, the underwriters on average price the IPO shares at the full information value, and the immediate after-market equilibrium price is on average higher than the full information value.
(2) In the underpricing -based explanation, the underwriters deliberately price the IPO shares below what they believe to be the full information value, and the immediate after-market equilibrium price is on average equal to the full information value.

My model predicts that in the long run, the IPO shares will underperform the shares of seasoned firms from similar risk category. The underpricing-based explanations are silent about the long-term abnormal performance of the IPO shares.

3. Vs overreaction

Among the three alternative models, overreaction model generates the most similar predictions as my model. Both are based on hypotheses that the underwriters price the IPO correctly and the immediate after-market price is on average higher than the full information value. However, the mainstream overreaction model uses psychological and/or behavioral arguments to get the results. My model put some economic reasons/structures to generate the results.

The overreaction model says nothing about the role of the truncated excess supply caused by the possibility to withdraw IPOs with very weak demand. This truncation/withdrawal phenomenon is a crucial integral part of my model. Based on this argument, (1) the overreaction model states that the unconditional distribution of investors' valuations in the immediate after-market has a mean that is greater than μ_0, and (2) my model states that the unconditional distribution of investors' valuations in the immediate after-market has a mean that is equal to μ_0, it is the (observed) conditional distribution (after adjusting for the truncated excess supply) that has a mean that is greater than μ_0. Unfortunately, this direct comparison is impossible. However, the existence of (a relatively many) withdrawn IPOs can be regarded as a weak/indirect evidence in favor of my model as opposed to the mainstream overreaction model. The existence of withdrawn IPOs lends support to the argument that it is the conditional distribution (as opposed to the unconditional distribution) of investors valuations that has a mean greater than μ_0.

III.10. Practical Implications

1. For issuers

The fact that a firm's shares experience high initial return in the immediate after-market does not necessarily mean that the firm did not get a fair price. The price set in the initial market is more likely reflecting the market-perceived true value per share than the excess

demand induced price in the immediate after-market.

Hot markets are characterized by larger fraction of investors receiving favorable information. During these periods, for a given market-perceived true value of share, the market is more absorbant. Issuing stocks during the hot markets may reduce the probability of cancelation due to lack of demand. Therefore, if the costs of waiting for window opportunity of temporarily hot period do not exceed the possible gain from the reduction of probability of failure, then waiting is an option to be considered.

2. For underwriters

On average underwriters have been doing a good job in pricing IPOs. To prevent disappointment/regret by the issuers that may occur after seeing price jump in the after-market, underwriters need to educate issuers that the excess demand induced prices in the immediate after-market on average do not reflect the market-perceived true value per share.

When the issuers can wait and the market is weak, it may be beneficial to advise the issuers to wait for a window of opportunity. It will reduce the probability of failure, increase the expected profit (by increasing the probability of success), and increase the underwriter reputation of being a high success rate IPO underwriter.

3. For investors

In valuing firms' shares, investors on average should put more weight on the price proposed by the underwriters. Long-term buy and hold strategy applied on buying IPO shares in the after-market just for the consideration of risk and return alone on average will be a bad strategy. Unless there is other reason, long-term investors should avoid that strategy.

4. For regulators

More disclosure of information about firms going public is on average beneficial because it will reduce the level of the heterogeneity of information facing investors. This in turn will reduce the average initial return. It will reduce the perceived 'money left on the table'. Issuers will be less regretful, which is good news for underwriters. It is also a good service for the IPO buyers. On average, it will reduce their underperformance while they still can satisfy their needs for completion of their portfolio.

III.11. Limitation of the Model

The specifications of investment banker's functions: Underwriting, marketing/distribution, and management of the IPO process, are not specifically analyzed by the model. Furthermore, the specialization in the task of capital provider vs information provider is not explicitly model and analyzed. The model assumes that investors will produce

information (gather information about the value of the firm's shares). The model is silent about the choice of producing information vs buying information, and/or allocation of wealth to get information (produce and buy) vs to invest in securities.

Contracting problems and potential incentives changes in relation to specific contract arrangements are not analyzed in the model. For example, the price setting behavior of the underwriters can be affected by structures of compensation contract (inclusion of warrants, cheap-stocks, an over-allotment option, etc.) To limit the scope of the model, these variables are put in the *ceteris paribus* basket. Readers who are interested in pursuing this line of research are advised to consult Dunbar (1992).

My model abstracts out from the choice between IPO/equity financing and other alternative financing sources. Self selection, censoring and truncation phenomena may play some roles in this choice. This choice can potentially have interesting implications.

III.12. Related Topics

1. IPO Vs seasoned offering

The issue to be addressed is to look for some economic differences between IPO and seasoned offering (SO) because SO has some similar procedures as IPO but the stock price behavior substantially differs. IPOs have an average positive initial returns/price jump, while SOs have a small negative average abnormal return (about -3%)[22] surrounding the announcement.

The main differences between IPOs and SOs are:
- IPO shares do not have publicly tradable price history and the ownership is very limited to relatively a few investors who may not be the highest bidders of the shares. Some investors with higher valuations can not buy the shares prior to the IPO. At the offering time, the channel to own the share is open. Investors with highest valuation can realize their desire to own the shares. Market will establish a completely new equilibrium based on the demand of the fraction investors who have the highest valuations.
- SO shares do have established publicly tradable price history in which price has been adjusted to reflect the market demand for the shares and all investors with highest bid/valuations already purchased the shares. The valuations also already incorporate the information about the coming seasoned offering. The effect of the seasoned offering is to increase the supply of similar shares. The new demand will have to be created by reducing the price slightly. When demand is still weak at that price, the offer can be withdrawn. It is very possible that on average there will be 'excess demand' (in the sense that the actual demand at the offering price is more than the expected demand which equals to the new/additional supply) at the offering price. But to start with the offering price is already lower. And unless new favorable information is revealed, the old price is more likely to be the upper bound when excess demand occur. Therefore, unlike in the IPO, in the SO there

[22] See Table 6-1 in Masulis, R., 1988, *The Debt/Equity Choice*, Ballinger Publishing Co., Massachusetts, p. 58.

are 2 opposing forces: (1) old price as an upper bound, and excess supply which lead to price reduction (2) 'excess demand' that may lead to price increase from the offering price. Due to the existence of the implicit upper bound, the net result will be negative abnormal return. Of course other explanations (agency, information, etc.) can be added to explain the negative reaction. The point here is: There are substantial differences between IPO and SO.

2. Spin-off, carve out, de-conglomeration

Equity carve-out represents the initial public sale of equity in a wholly owned subsidiary of a parent firm. Spin-off occurs when a parent company distributes its entire holdings of stock in a subsidiary to the parent's stockholders. Equity carve-out and spin-off cause a parent company and its subsidiary to be valued separately. Empirical research documented small positive announcement return on the parent company's stock (about 2% for carve-outs and 3% for spin-off).[23]

Using the heterogeneous information argument, the phenomena can be explained as follows. Assume that information gathering by an investor is abstracted as if he collect n random sample from the unconditional distribution of firm's value v. We will compare two events: (1) valuation of two companies (parent -v_1- and subsidiary -v_2-) as separate unit, (2) valuation of both as one company. Probability that an investor collect favorable information for one company, is greater than probability of that investor to collect favorable information for both companies at the same time, i.e.,
Prob ($v_1 > P_1^*$) > Prob($v_1 > P_1^*$ AND $v_2 > P_2^*$) = Prob($v_1 > P_1^*$) x Prob($v_2 > P_2^*$).

Using similar reasoning, Prob(N investors collect favorable information for parent AND N investors receive favorable information for subsidiary) > Prob(N investors receive favorable info for both parent and subsidiary at the same time). Therefore, if it is possible for investors to value the parent company separately, there is a higher probability that more investors collect favorable information and bid the price up. Other things being equal, heterogeneous information theory predicts that equity carve-outs, spin-offs, divestitures are good news for parent company's shares.

Extending this reasoning to breaking up conglomerate companies, the model predict that other things being equal, the break up value of conglomerates is on average greater than the value of the conglomerates. This empirical evidence was documented by LeBaron and Speidell.[24]

3. Merger/acquisition

It is well documented in the merger/acquisition literatures that the return to the shareholders of acquired firms is significantly positive, and acquirers seem to overpay

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[23] Ibid, p.74

[24] In Bhagat, S., A. Shleifer, and R. Vishny, 1990, Hostile Takeovers in the 1980s: The Return to Corporate Specialization', Brookings Papers on Economic Activity: Microeconomics, p 9.

(return to the acquirers' shareholders is negative, especially for period after 1968 and when there is competition among several bidders[25], also the post merger performance of the acquiring firms suffer a statistically significant loss of about 10% over the 5-year post merger period.[26] This phenomenon is in line with the heterogenous valuation model. The acquirer is the investor who has the highest valuation and happen to control large amount of money to buy all or most of the acquired company's shares. Other things being equal, the bidders pay a price higher than the full information value. Roll's Hubris Hypothesis[27] is one varian along this line of thinking.

Combining two companies is a reverse process of divestitures/spin-offs/carve-outs. The acquiring company's shares were held by investors who were the highest bidders for the acquiring company's as a separate company. They are not necessarily the highest bidders for the combination of acquiring and acquired companies. Following similar reasoning as in previous sub-section, other things being equal, heterogeneous information theory predicts that merger is not a good news for the acquiring company.

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[25] Bradley, M., A. Desai, and E. H. Kim, 1988, 'Synergistic gains from Corporate Acquisitions and their division between shareholder of target and acquiring firms', *Journal of Financial Economics*, 3-40.

[26] Agrawal, A., J. Jaffe, and G. Mandelker, 1992,'The Post-Merger Performance of Acquiring Firms: A Re-examination of an Anomaly', *The Journal of Finance*, 1605-1621.

[27] R. Roll, 1986,'The Hubris Hypothesis of Corporate Takeovers', *Journal of Business*, 197-215.

IV. SUMMARY AND CONCLUSIONS

There are three important IPO anomalies: the positive average initial return (improperly called short-term 'underpricing'), the long-term underperformance, and the cycle of hot/cold issue markets.

The existing explanations are either based on the assumption of underpricing by underwriter in the initial market, or overreaction/irrationality of investors in the immediate after-market. Unlike the mainstream explanations, my model explains the 'underpricing' based on assumption that underwriter sets the initial price equal to the market-perceived true value according to underwriter's valuation and investors are rational. The model can explain a lot of seemingly anomalous phenomena in the IPO market for underwritten IPOs of firms' stock.

The main driving forces of my model are the heterogeneous information (that leads to differences in valuations among rational investors), average excess demand, and the fact that underwriters are long-term participants in the IPO market. The average excess demand is generated because we only observe a truncated distribution of the difference between supply and demand. The truncation is caused by the possibility to withdraw the IPOs when demand is very disappointing.

Some implications of my model for the IPO market are:
1. Positive average initial return.
2. Long-term average underperformance.
3. Positive relation between uncertainty in valuation and initial return.
4. Negative relation between quality of certifiers and initial return.

Using the relation between the thickness of the tail of the demand distribution and the initial return, my model can also explain the existence of the hot/cold issue markets anomaly and partial adjustment phenomenon. The model also predicts that the involvement of (informed) institutional investors will reduce the level of initial return.

Several hypotheses to directly test the model are suggested:
H1: IPOs with excess demand have positive average initial return.
H2: The number of IPOs with excess demand is greater than the number of IPOs with excess supply.
H3: Hot issue periods are characterized by above average excess demand, and/or above average uncertainty in investors' valuations on the IPO shares.
H4: Fraction of withdrawn IPOs is smaller (larger) during the hot (cold) issue periods.
H5: Best efforts (firm commitment) IPOs are characterized with higher (lower) excess demand, and/or higher (lower) uncertainty in investors' valuations.
H6: IPOs with excess demand have more negative long-term abnormal performance
H7: IPOs during hot (cold) issue periods have more (less) negative long-term abnormal performance

H8: Best efforts (firm commitment) IPOs have worse (better) long-term abnormal performance.

Comparative tests to differentiate my model and the other explanations are also described. For comparison with the price support and underpricing based explanations, the comparative tests are based on the relation between initial return and long-term performance of the stocks. For comparison with the overreaction model, the test is based on conditional vs. unconditional distribution of valuations.

Extensive information disclosure about firms going public is beneficial to all parties involved. Long-term investors should not buy (and hold) IPO shares in the after-market just for the consideration of risk and return alone.

As the logical next steps, I plan to do empirical studies to test the implications. Furthermore, the logic behind the model -truncation and heterogeneous information- can be very useful for analyzing many other phenomena in other research areas.

APPENDIX 1. IPO PROCEDURES

STEP 1. Preliminary meeting/information exchange between firm and lead underwriter

STEP 2. Negotiation between firm and lead underwriter:
Letter of intent, and preparation of registration statement (initial prospectus, draft of underwriting agreement, etc.)

STEP 3. [Optional]: Pre-filing conference with the SEC

STEP 4. Filing the registration statement with the regulators: SEC, NASD, States ('Blue-sky' laws)

STEP 5.
a. Selling efforts are allowed to be carried out: Forming underwriter syndication, distributing the 'red herring' prospectus, publishing 'tombstone' ads, conducting 'road show', receiving indications of interest.
b. Waiting period: SEC, NASD, States review the filed documents

STEP 6. Receiving comments from SEC, NASD, States.
If, there are substantial objections from the regulatory institutions, then firm/underwriter will revise the documents (pre-effective amendment) and refile them with the regulatory institutions, and go back to STEP 5 b.
If there is not any objections, then the SEC declares the registration statement effective.

STEP 7. Final pricing meeting to agree upon the offer price, compensation terms.

STEP 8. Filing the pricing amendment. Start collecting oral commitments of sales on effective date.

STEP 9. If the regulatory bodies have objections to the final pricing amendment, then all confirmed sales is cancelled. Post-effective amendment is filed. Go back to step 5 b.

STEP 10. Final prospectus is sent to buyers to confirmed sales.

STEP 11. Closing. Firm receives funds from the underwriter according to the final underwriting agreement.

General Comments

The underwriting agreement does not become effective/binding until it is signed after step 7. In the meantime, the relation between the firm and the underwriter is guided by the letter of intent. In this firm commitment offers, the underwriter effectively does not guarantee anything until the final prospectus is issued.

In a best efforts offer, offer price, minimum/maximum number of shares to be sold are agreed upon. After the SEC approves the offering, the underwriter circulates the prospectus and try its best efforts to sell the shares to investors. The indications of interest are collected during this period by depositing investors' money in an escrow account. The offer will be withdrawn if until a specified period of time the total number of shares sold has not reached the minimum required. The money in the escrow account will be refunded to the investors.

Example of Time Table of a Typical IPO Process

Week	***Activity***
1	Information exchange meeting
:	
:	Negotiations of terms of contracts, signing letter of intent
:	
6	Draft of Registration Statement
7	Revision of the draft
8	Final draft agreed
9	File Registration Statement with the regulatory bodies
:	Circulation of 'red herring' prospectus,
:	road show, 'tombstone' ads,
:	collecting indications of interest,
:	registration statement is being reviewed by the regulatory bodies
13	Receive Comment Letters from SEC
14	Final revisions, pricings
	Oral sales
	Effective date,
	distribution of final prospectus, confirmed oral sales
15	Closing, firm receives funds

Appendix 1 is based on the following sources:

Arkebauer, J. B., and R. Schultz, (1991), *Cashing Out: The Entrepreneur's Guide to Going Public*, Harper Business, USA.

Dunbar, C, (1992), *The Effect of Information Asymmetries on the Choice of Underwriter Compensation Contract in IPOs*, working paper, University of Rochester, NY.

Ernst&Whinney, (1984), Deciding to Go Public: Understanding the Process and the Alternatives, Ernst & Whinney, USA.

Riley, J. E, and L. H. Simons, III, (1994), *How to Prepare an IPO*, Practising Law Institute, New York.

APPENDIX 2. EXAMPLE OF BAYESIAN UPDATING

Suppose the prior density for $\Theta \sim g(\theta) = N(\mu, \sigma^2)$
New information comes in form of a random sample of size n:
$\mathbf{X}n = X_1, X_2,...,X_n$, from $f_{X|\Theta}(x|\theta) \sim N(\theta,\sigma^2)$
The posterior distribution of Θ given the new information becomes:

$$f_{\Theta|\mathbf{X}n}(\theta|\mathbf{x}n) = \frac{f_{\mathbf{X}n|\Theta}(\mathbf{x}n|\theta)\ g(\theta)}{f_{\mathbf{X}n}(\mathbf{x}n)} = \frac{[\prod_{i=1}^{n} f_{Xi|\Theta}(xi|\theta)]\ g(\theta)}{\int_{-\sim}^{\sim} [\prod_{i=1}^{n} f_{Xi|\Theta}(xi|\theta)]\ g(\theta)\ d\theta}$$

$$= \frac{(2\pi\sigma^2)^{-n/2} \exp[-\frac{1}{2\sigma^2}\sum_{i=1}^{n}(x_i-\theta)^2]\ \ (2\pi\sigma^2)^{-1/2} \exp[-\frac{1}{2\sigma^2}(\theta-\mu)^2]}{\int_{-\sim}^{\sim} (2\pi\sigma^2)^{-n/2} \exp[-\frac{1}{2\sigma^2}\sum_{i=1}^{n}(x_i-\theta)^2]\ \ (2\pi\sigma^2)^{-1/2} \exp[-\frac{1}{2\sigma^2}(\theta-\mu)^2]\ d\theta}$$

$$= \frac{\exp[-\frac{1}{2\sigma^2}\sum_{i=0}^{n}(x_i-\theta)^2]}{\int_{-\sim}^{\sim} \exp[-\frac{1}{2\sigma^2}\sum_{i=0}^{n}(x_i-\theta)^2]\ d\theta} \qquad (\text{Let } x_0 = \mu)$$

$$= \frac{\exp[-\frac{1}{2\sigma^2}\{(n+1)\theta^2 - 2\theta\sum_{i=0}^{n}x_i + \sum_{i=0}^{n}x_i^2\}]}{\int_{-\sim}^{\sim} \exp[-\frac{1}{2\sigma^2}\{(n+1)\theta^2 - 2\theta\sum_{i=0}^{n}x_i + \sum_{i=0}^{n}x_i^2\}]\ d\theta}$$

multiplying both numerator and denominator by $\exp[-\frac{n+1}{2\sigma^2}(\sum_{i=0}^{n}\frac{x_i}{(n+1)})^2]$

and dividing both by $\exp[-\frac{1}{2\sigma^2}\sum_{i=0}^{n}x_i^2]$

$$= \frac{\exp[-(\frac{n+1}{2\sigma^2})\{\theta^2 - 2\theta\sum_{i=0}^{n}\frac{x_i}{n+1} + (\sum_{i=0}^{n}\frac{x_i}{(n+1)})^2\}]}{\int_{-\sim}^{\sim} \exp[-(\frac{n+1}{2\sigma^2})\{\theta^2 - 2\theta\sum_{i=0}^{n}\frac{x_i}{n+1} + (\sum_{i=0}^{n}\frac{x_i}{(n+1)})^2\}]\ d\theta}$$

$$= \frac{\frac{1}{\sqrt{2\pi\sigma^2/(n+1)}}}{\frac{1}{\sqrt{2\pi\sigma^2/(n+1)}}} \frac{\exp\{-(\frac{n+1}{2\sigma^2})[\theta - \sum_{i=0}^{n}\frac{x_i}{(n+1)}]^2\}}{\int_{-\sim}^{\sim} \exp\{-(\frac{n+1}{2\sigma^2})[\theta - \sum_{i=0}^{n}\frac{x_i}{(n+1)}]^2\}\ d\theta}$$

$$= \frac{1}{\sqrt{2\pi\sigma^2/(n+1)}} \exp\{-(\frac{1}{2\sigma^2/(n+1)})\,[\theta - \sum_{i=0}^{n} \frac{x_i}{(n+1)}]^2\} \sim N(\sum_{i=0}^{n} \frac{x_i}{(n+1)}, \frac{\sigma^2}{(n+1)})$$

Therefore $E(\Theta \mid \mathbf{X}n) = \sum_{i=0}^{n} \frac{x_i}{(n+1)} = \frac{\mu + n\sum_{i=1}^{n} \frac{x_i}{n}}{(n+1)} = \frac{\mu + n\ \bar{X}_n}{(n+1)}$

which is a kind of weighted average of the prior mean and the sample mean.

If $\bar{X}_n > \mu$ then $\mu < \frac{\mu + n\ \bar{X}_n}{(n+1)} < \bar{X}_n$.

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IPO: Price support vs Heterogeneous Information
Price support implies:
(1) IF zero initial return THEN long-term underperformance
IF positive initial return THEN no long-term underperformance

(2) No relation between excess demand and initial return and underperformance

Heterogeneous information implies:
(1) IF positive initial return THEN long-term underperformance
IF zero initial return THEN no long-term underperformance

(2) Excess demand --> positive initial return --> long-term underperformance
no excess demand --> insignificant initial return --> no long-term underperformance

- Model the effect of P/E limitation on the price behavior of the IPO stocks (P/E limitation was introduced to Jakarta Stock Exchange and later the restriction was softened)
- Model the effect of limitation in foreign investors' holding on the price behavior of the stocks.
- Herd behavior, heterogeneous information and IPO initial returns.

Empirical research:
- Check the average holding period in relation to the after market price decline. when optimistic investors start to sell, price decline because they cannot find buyers at current price. Recall strong hand phenomenon discussed by Aggarwal and Rivoli (1990).
- Study management turnover after IPO, introduction of option as a part of managerial compensation, vs long-term performance of IPO
- Modelling effect of P/E limitation on the underpricing
- Tangible vs intangible asset and underpricing. (Implication of my model: more tangible, less uncertainty, lower initial return).
- Study the behavior of IPO stock prices in the Jakarta Stock Exchange.

In addition to developing a new model, I also plan to use a new data set -the Indonesian stock market data- to investigate the short-term underpricing, long-term underperformance, the cycle of the hot and cold issued period, and the effect of foreign ownership and P/E limitation. Moreover, I plan to investigate the use of IPO as a mean to privatize state-owned enterprises.
- To some extent, selling stock is like selling dollar bill whose value changes over time (the point is, there is intrinsic market-perceived true value, but it can change over time). Market price based on S/D under less than perfect market conditions is not always in line with the market-perceived true value. However, over time it will converge to the market-perceived true value.
Useful findings:
- - Kim, Krinsky and Lee (JBFA 93), using 177 IPO listed on the Korean Stock Exchange 1988-1990, avrg IR is substantially higher when entrepreneur view the equity financing as

a last resort for raising funds (68.9%) than it is when existing shareholders intend to diversify their portfolio holding (40.22%)
- Affleck-Graves, Hegde, Miller, Reilly (FM 93) using data 1983-87: Avg UP NYSE and AMEX (auction mkt) is 4.82% and 2.16% , Nasdaq NMS and non National Market System (negotiated dealer market) 5.56% and 10.41%. For long-term performance of NASDAQ and NYSE IPO see Loughran (JFE 93)
- Alternative measurement of IR from the point of view of issuer and investors, see McGuiness (Omega, May 1993)
- Jang & Lin (JAPubl Pol 1993), Trading volume on the first trading days was significantly larger for Big 8 9accounting firm) clients than for non-Big 8 ones;no clear difference for several subsequent days; a reverse relationship emerged from day 6 to 30 in which the daily volume was smaller for Big 8 client than for non big 8 firms. The hypothesis is:trading volume reaction to a release of more reliable information is initially stronger but less persistent
- Opening price of IPO and closing price to study intraday behavior (whether all initial return is captured only by the initial purchaser, see for example Barry and Jennings (FM 93))
- Pricing of auditor fee, Beatty JAR 1993:
    * IPO clients are more likely to exhibit financial distress than establish client
    * IPO auditor compensation is related to the traditional audit fee model variables. Auditors charge a conditionally higher fee for client that subsequently filed for bankruptcy, were delisted or were the subject to a shareholder lawsuit.
- For reverse LBO 1983-88, Mian and Rosenfeld (FM 93) documented that there was no long-term underperformance.

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