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An empirical extension of Rock's IPO underpricing model to three distinct groups of investors

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This article examines earned returns and allocation details of more than 200 new offerings (Initial Public Offering, IPO) from companies that went public in Hong Kong during the period 1988 to 1995. Three distinct groups of investors are identified, each exhibiting a particular type of return's pattern. Each pattern seems to correspond to a specific level of information. This finding is of particular interest as it shows the level of return that an investor can expect from IPO investments, also being an extension of previous studies where, following Rock (1986), two, not three, groups of investors are identified. This article also finds that expected returns from IPOs remain positive and highly significant after adjusting for the allocation bias. With the exception of the smallest application sizes, results are invariant to adjustments such as transaction costs and the risk-free rate of return.

I. Introduction

Perhaps the best-known and most studied explanation for the underpricing of unseasoned equity offerings is the adverse selection model proposed by Rock (1986). According to this model, the underpricing of an offering stems from a rational decision of issuing firms facing informational asymmetries among potential investors.

Investors, according to Rock, are differentiated by their levels of information regarding the true value of the issue, with informed investors having superior information and uninformed investors knowing only the probability distribution of such value. At a given cost, investors can acquire information regarding the share's true value. Those who incur such cost are termed 'informed' investors. Given their superior information, informed investors are in a better position to decide whether or not a new offering is worth participating. They will submit purchasing orders only when a new issue is known to be rewarding and underpricing is anticipated. By contrast, uninformed investors will submit purchasing orders indiscriminately.

Given the presence in the market of informed investors, investors who remain uninformed face a winner's curse: they receive a disproportionately high allocation of overpriced shares as informed investors avoid subscribing to such new offering. Conversely, they receive a disproportionately low allocation of underpriced shares as informed investors are then present in the market. Therefore, receiving a large allocation of new shares is bad news for uninformed investors.

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Investors who submit purchase orders indiscriminately are expected to earn a return that is conditional upon receiving shares. Such return, named 'allocation-adjusted' return, is smaller than the expected return of the subscription. Indeed, Rock (1986) suggests that it should not be higher than the risk-free rate. This is why, in order to entice uninformed investors to remain in the market, new issuers underprice offerings.

Most of the empirical testing of the Rock's (1986) model concentrates on examining the relationship between initial returns and uncertainty surrounding after-market clearing prices. A more direct test involves observing how new shares are rationed across different application sizes and the corresponding levels of returns. However, information about allocation details is not readily obtainable in some important new issue markets such as in New York. Koh and Walter (1989) were the first to conduct such type of direct test using data from the Singapore market where allocation details are made public. They found that, between 1973 and 1987, 90% of the new issues were oversubscribed and the average oversubscription rate was 29 times the offering size. When examining the underpricing level of Singaporean new offerings, initial excess returns of approximately 27% above the risk-free rate were reported. However, when the probabilities of obtaining an allocation were incorporated into the estimation of expected returns, these allocation-adjusted returns drop to as low as 0.5%. In addition, no application strategies produce returns that are significantly different from zero. Similar results are reported by Lee *et al*. (1996) when examining Singaporean new offerings listed between 1987 and 1992. These findings provide strong statistical evidence in support of the Rock (1986) model as the expected returns conditional upon receiving shares are less than that from submitting a bid. Results also show that new issues must indeed be offered at a discount so as to produce a nonnegative allocation-weighted return.

Levis (1990) performed a similar test using new offerings listed in London. For the entire sample of 123 new offerings, the average market-adjusted discount is 8.6%. In order to determine initial returns for different application sizes, 13 arbitrary size levels were examined. Results show that, after being adjusted for the probability of receiving shares, returns increase with the size of an application. Small investors often receive less shares than the number they have applied for and, in some largely oversubscribed issues, those who fall into small-sized levels have less than 1 chance in 10 of receiving any share at all. Again, it is obvious that underpricing is necessary to entice small investors to participate in the new issues market. It is intuitively accepted that small investors and uninformed investors are the same group.

When examining a sample of Finnish new offerings in 1993, Keloharju found that uninformed investors (those who fall into small-sized application levels) obtain, on average, a larger allocation from offerings with negative returns than from offerings with positive returns. An allocation bias is thus clearly visible. Although the average unconditional returns range from 7.1 to 9.1%, the average allocation-adjusted returns are much lower and, in general, negative. The winner's curse clearly reduces the average returns available to uninformed investors. Such reduction is less severe in Finland than in Singapore.[1]

In Hong Kong, where allocation details are available, studies on allocation-adjusted returns have been performed by Cheung *et al*. (1993) and McGuinness (1993). The former report an underpricing level that ranges from 12% (for application sizes of 2000 shares) to 14.6% (for 4.5 million shares or more), but the consideration of the probabilities of obtaining new shares reduces these returns significantly. For some application levels (2000–90 000 shares), it seems possible to earn returns above the risk-free rate. McGuinness (1993) observed similar levels of underpricing, but small-sized applications ($< 20\,000$ shares) produce initial returns that are not significantly different from zero.

The present study also concentrates on the analysis of allocation-adjusted returns but it increases the number of examined Initial Public Offerings (IPOs) to over 200 (compared with samples of around 100 issuing firms in previous studies, see Table 1). Consequently, the study is able to examine a larger number of size levels of applications. There are two reasons why a large sample and the corresponding possibility of increasing the number of examined levels may enhance our knowledge of initial offerings. First, the true picture drawn by allocation-adjusted returns only emerges when the number of levels examined approaches reality. In order to measure how the probability of obtaining an allotment affects initial returns (the case of small investors) it is indeed necessary to examine application

[1] For instance, for a subscription level of FIM100 000 in the Keloharju's (1993) study, the difference between unconditional and allocation-adjusted returns is 11%, whereas in the study of Koh and Walter (1989), a difference of approximately 26% is recorded.

Table 1. Studies on allocation-adjusted initial returns of IPOs in different countries

Studies	Countries	Sample period	Sample sizes
McGuinness (1993)	Hong Kong	1980–1990	92
Cheung *et al.* (1993)	Hong Kong	1986–1991	99
Koh and Walter (1989)	Singapore	1973–1987	66
Lee *et al.* (1996)	Singapore	1987–1992	62
Levis (1990)	United Kingdom	1985–1988	123
Keloharju (1993)	Finland	1984–1989	80

levels in detail. The second reason is that, according to a survey conducted by the Stock Exchange of Hong Kong (SEHK, 1997), there are three distinct groups of investors in Hong Kong. It is interesting to empirically confirm whether such three groups are also present in IPOs and to interpret results in the light of the Rock (1986) model where, as mentioned, only two groups are considered. This, in turn, requires samples with sufficient discriminating power.

According to the mentioned survey, retail investors in Hong Kong are of two types. The first type includes white collar investors in their late 30s or above and with secondary education or above. These investors tend to adjust their portfolio[2] frequently to take short-term profit opportunities. They rely mainly on personal study and commentaries in newspapers for making investment decisions.[3] The second retail group of investors identified are younger, with lower education level and income.[4] Indeed, given the popularity of stock investment in Hong Kong, it is not uncommon to find the young and the very small investors actively trading securities.

According to Rock (1986), investors are either informed or uninformed. If the difference in socio-economic profiles between the two groups of retail investors in Hong Kong really affects their investment strategy and the associated returns level, then we should expect a total of three groups of investors, not just two. Indeed, besides the younger investors' group, probably the least informed with lower educational level and income, and the white-collar investors' group, probably with higher educational level and income, there is also the nonretail, institutional group of investors to be considered. This is the group of the most informed and wealthiest participants.

From the mentioned survey, it is also known that personal study and commentaries in the newspapers are the key sources of information for retail investors. Of the three groups, younger investors are the less informed. They tend to submit applications indiscriminately and to be constrained to a given amount of wealth. Their investment strategy thus approaches that of the uninformed investors in the Rock model.

White collar investors are able, to some extent, to distinguish between the good and not so good issues. They apply for more shares if publicly available information on a new offering is positive. This group may even 'read between the lines' of publicly available news and reports or perform some simple analysis[5] of IPO investments.

Institutional investors are the most experienced and knowledgeable. They have access to large amounts of money and they may possess information beyond that in the prospectus, thus being able to perform a careful stock selection. Their investment strategy thus approaches that of the informed investors in the Rock (1986) model.

This article sets out to ascertain whether three groups of investors indeed exist in IPOs and is organized as follows. Section II describes the data and methodology. Section III reports on the empirical results. Section IV summarizes the conclusions.

II. Data and Methodology

A total of 251 companies were listed between 1988 and 1995[6] as recorded in the fact books published by the SEHK.[7] Prospectuses are the source of information such as the subscription price and timetable of a new offering. The latter stipulates the deadline for lodging an application (closing day), the date at which a cheque in respect of a wholly or partially unsuccessful application is refunded, and the date at

[2] The average portfolio size is HK$150 000 and the average deal size is HK$50 000.
[3] Suggestion from friends and relatives is also another important source of information.
[4] For the white collar group the average income is in excess of HK$30 000, while for the younger group the average income is around HK$16 000.
[5] As indicated by Vong (2006), among all the financial information disclosed, the informational content of the price/earning ratio is routinely checked by these investors.
[6] This sample period is purposely chosen because, starting from 1993 onwards, some new issues went to a dual tranche mode of sale (McGuinness, 1999). Our sample is clean from this issue as we only focus on local IPOs.
[7] Companies that had adopted offer for subscription or offer for sale or both as their listing methods are included in our sample.

which shares begin to be traded. Given that new share applications in Hong Kong are required to be accompanied by full payment, all these dates are essential for the computation of the interest costs associated with an IPO's investment. As for the computation of initial returns, the closing price on the first day of trading is collected from the daily quotation sheet of the SEHK.[8]

Assuming that investors apply for new shares on the last day of an offering[9] and sell off their holdings on the first trading day, the number of days during which application monies are frozen falls between the closing day for an application and the first day of public flotation. This is true if the applicants succeed in obtaining a full allocation. For applicants who obtain a partial allocation, another period needs to be considered, namely, the time span between the closing day for an application and the date when refunded monies are posted to applicants.

It is assumed that investors borrow application monies from banks. The corresponding interest rate incurred is proxied in this study by the lending rate offered by banks.[10] Besides, the interest rate offered by Hong Kong Monetary Bills is used as a proxy for the risk-free rate of return. The latter is also required as Rock argues that, when the effect of allocation methods is included into the model, returns earned on new shares' applications should not differ from the risk-free rate.[11]

The allotment plan for the distribution of new shares is decided upon by issuers, together with underwriters, only after the application deadline. This plan will then be published in Hong Kong newspapers and from them, the probability of receiving an allocation and the actual number of shares obtained by an applicant can be estimated. When all the above information is in place, allocation-adjusted returns can be computed.

Initial returns

The initial return of a new offering is the percentage difference between the first aftermarket price and the offering price:

$$\text{Initial return} = \left[\frac{P_{c,i} - P_{o,i}}{P_{o,i}}\right] \times 100$$

where

$P_{c,i}$ = the closing price on the first day of public flotation in issue i

$P_{o,i}$ = the offering price of an issue i

The higher the return, the more underpriced an offering is assumed to be. This assessment of the underpricing level is consistent with McGuinness (1992) and Alli *et al*. (1994) who both document a significant mean daily return for the first listing day but not for subsequent days. In some studies returns are also adjusted by the variability of the market but, as Beatty and Ritter (1986) note, such adjustment produces a negligible effect.

The above measurement of an initial return is applicable only if an investor obtains the number of new shares that he/she has applied for. In many cases this is not so as the number of shares allocated to each investor depends on the subscription level of a new offering (the total number of shares applied for divided by the number of shares on sale in an IPO). When an offering is oversubscribed (a subscription level greater than one), some rationing method must be applied. From the observation of such method, the probability of a given investor receiving an allocation can be estimated. For offerings that are not oversubscribed, the probability of obtaining an allocation is one.

Investment bankers enjoy considerable discretion over the method of allotment to be used in case of oversubscription. They can use any method they see fit so long as it is equitable. The rationing procedures employed in Hong Kong usually are of three types: balloting, scaling down or a combination of the latter (McGuinness, 1993). All of these methods use units (lots) of, typically, 1000 shares. Depending on the number of lots applied for, applications will fall into a pre-defined level. Rationing rules apply to a given level but differ amongst levels.

When balloting is used, new shares are distributed to a reduced number of applicants using some form of random selection. Therefore applicants may not receive an allotment of shares and the probability of being allotted shares is smaller than one. This method leads to a reduced pool of investors and, as pointed out by Levis (1990), ballots are biased against small investors.

In the second approach, scaling down, every individual investor receives an allocation, the

[8] Closing prices may also be found in DATASTREAM.

[9] Since it is impossible to figure out when investors will submit their applications of new shares, we assume that they do it on the last day of the offer period.

[10] In order to minimize the difference between interests lost on saving and interest charged on bank loans, the prime rate (the rate charged to the most favoured customers) is used in the study.

[11] Both prime and risk-free rates are taken from DATASTREAM.

probability of being allocated new shares being therefore one. Nonetheless, in oversubscribed offers, only a fraction of the total number of shares that an investor has applied for is received. Again, the degree and method of scaling down is entirely at the discretion of investment bankers; it may involve any pattern they see fit and best suits the newly listed company. Clearly, when compared with the balloting allocation method, this approach results in a larger pool of investors. Very often, instead of adopting a pure balloting or scaling down approach, a combination of them is utilized.

With the disclosure of rationing methods and assuming that an investor's application for new shares is nondiscriminatory, a monetary rate of return for a given subscription size level may be estimated. In cases where the probability of obtaining an allocation is smaller than one, instead of using the number of shares applied for, returns are computed using N_r, the number of shares actually received by an applicant. Under the balloting method, N_r represents the number of shares that have been distributed to those applicants who are selected from the ballot. In the scaling down method, N_r represents the actual number of shares being allotted to an applicant for a particular application level. Once the number of shares received by an applicant is estimated, a corrected rate of return for a particular subscription size in issue i can be computed at the close of the first trading day. This allocation-adjusted return for a particular application size a in issue i, is

$$R_{a,i} = \frac{N_{r,i}(P_{c,i} - P_{o,i})}{N_{r,i} \times P_{o,i}}$$

where

$R_{a,i}$ = the initial rate of return from an application of order size a in issue i

$N_{r,i}$ = the number of shares received from an application of order size a in issue i

This form of estimation only applies to new offerings taking up the scaling down method of allocation, where all the applicants succeed in obtaining an allocation of new shares. For oversubscribed new offerings adopting the balloting approach, the initial rate of return is adjusted to reflect the chance of getting new shares, by multiplying it by pr_i, the probability of an allotment being obtained. The expected initial excess rate of return is, in this case,

$$E(R_{a,i}) = pr_i \times R_{a,i}$$

Transaction costs

Similar to the British institutional framework, applications for new shares in an initial public offering in Hong Kong must be accompanied by payment for the full amount. Therefore, the financing of an application involves a cost, which can be estimated with certainty at the time of the application (McGuinness, 1993). This cost depends on the application size, the daily interest rate and the number of days funds are tied up. Total transaction costs (TC_i) for a particular application level in offering i is

$$TC_i = (N_{a,i} - N_{r,i})P_{o,i}\left[(1+r)^{d1,i} - 1\right] + N_{r,i} \times P_{o,i}\left[(1+r)^{d2,i} - 1\right] + FC + BR$$

where

$N_{a,i}$ = number of shares applied for in issue i

$N_{r,i}$ = number of shares received in issue i

$P_{o,i}$ = the offering price of an issue i

r = Hong Kong and Shanghai Banking Corporation's best quoted lending rate (expressed as a daily rate)

$d1,i$ = number of days from the closing of applications for issue i to the date at which application monies are refunded to the applicant

$d2,i$ = number of days from the closing of applications for issue i to the first day of public trading

FC = fixed cost involved in an application for shares

BR = brokerage costs of applying for shares (1% of the offer value of shares actually received)

The above costs reflect the settlement procedures adopted for new offerings applications in Hong Kong. They contain four elements. The first is the cost $[(N_{a,i} - N_{r,i})P_{o,i}]$ of monies refunded to applicants who received a partial allocation of new shares. Interest on amounts refunded depends on the cost of money and the length of time during which the fund is being tied up. The second, $N_{r,i} \times P_{o,i}$, also relates to application monies. Interest on these monies is higher than that of the refunded monies since they are being logged up until new shares are publicly listed. The third encompasses several expenses incurred as a result of the preparation of a banker draft for the payment of applications, postage and other miscellaneous costs. In line with McGuinness (1993), these costs, FC, are estimated to be HK$100. Finally, the brokerage cost, BR, is also estimated to be 1% of the offer value.

The above transaction costs are then expressed on a per share basis, TCSH (transaction costs divided by the number of shares received) and subtracted from prices. The expected level of net return for application level a in issue i is

$$E(\mathrm{NETR}_{a,i}) = \mathrm{pr}_i[N_{\mathrm{r},i}(P_{\mathrm{c},i} - P_{\mathrm{o},i} - \mathrm{TCSH})/N_{\mathrm{r},i} \times P_{\mathrm{o},i}]$$

III. Empirical Results

Table 2 shows the number of new offerings for the selected years. Over 60% of the sample corresponds to companies listed between 1991 and 1993. Such high level of IPO activity in a small period was also reported by McGuinness (1992)[12] for the period 1987 to 1988. The present study observed an underpricing of 16% in the average initial returns. This suggests some improvement over the level of 17.6% reported by McGuinness (1992). These returns were computed without considering transaction costs on the assumption that investors receive an allocation of new shares.

Table 2. Distribution of IPOs in Hong Kong: 1988–1995

Year	Number of IPOs	Number of IPOs expressed as % of total
1988	19	7.57
1989	5	2.00
1990	11	4.38
1991	48	19.12
1992	53	21.11
1993	55	21.91
1994	38	15.14
1995	22	8.76
Total	251	100.00

Table 3. Subscription rates: underpriced compared with overpriced offerings

	Underpriced IPOs (initial returns > 0)	Overpriced IPOs (initial returns < 0)	Others (initial returns = 0)
Cases	156 (75%)	46 (22%)	5 (3%)
SR(Mean)	85.29	11.13	10.77
SR (SD)	127.97	19.07	11.77
SR (Minimum)	0.65	0.11	1.09
SR (Maximum)	658.38	98.67	30.75

Subscription rates and initial returns

It is common that Hong Kong investors receive only a partial allotment of new shares or even no shares at all. In computing initial returns, the allotment method whereby shares are distributed among investors must be taken into account. Of the 212 IPOs examined, five contained only a sketchy description of the rationing method used and were withdrawn from the sample. Given that Rock (1986) argues that underpriced offerings (initial returns > 0) should be preceded by higher Subscription Rates (SRs) than those observed for overpriced offerings (initial returns < 0), the sample is partitioned into such two groups and their SRs are examined. Table 3 shows the results. For the whole sample, 156 offerings (75%) have initial returns greater than zero while 51 offerings (25%) have returns smaller than or equal to zero. For the underpriced group, the mean SR is as high as 85.29 times the number of new shares offered. For overpriced offerings, the mean SR is only 11.13 times the number of shares offered. Parametric t tests suggest that both SRs and initial returns are significantly higher for the underpriced group than for the overpriced group.[13]

Table 4 shows the breakdown of SRs and the associated returns level for the two groups of offerings, underpriced and overpriced. In general, this level increases with the rate of subscription.[14] For the underpriced group, initial returns increase with SRs, excepting where SRs are between 50 and 100 times. The same trend is recorded for the overpriced group except for one offering.

Except for two offerings, all other underpriced offerings have SRs in excess of one. As for the overpriced group, only three offerings are

[12] McGuinness observed that the number of IPOs soared from 5 in 1986 to 15 in 1987 and 19 in 1988. While McGuinness attributed his findings to the unification of Hong Kong's four stock exchanges into one trading centre, the SEHK, we believe that such a surge in new offerings during our sample period might be the result of the 4 June 1989 incident which exerted a disastrous impact on the stock market. Consequently, a backlog of issuers may have delayed their listing until a time when a more reasonable offer price would have been obtainable. This may partly explain the collection of IPOs in 1991, 1992 and 1993.

[13] Subscription rates: mean difference of 74.153, $t = 6.938$; initial returns: mean difference of 0.315, $t = 12.584$.

[14] The significant positive relation between SR and initial returns has been reported by Vong (2006). The study shows that when initial return is regressed against the SR only, around 55% of its variability is explained. When other variables are included into the regression, earnings as well as warrants become significant factors influencing the returns. Examples of other studies which have also reported the significance of SR in understanding initial returns include Huang (1999) and Tan *et al.* (1999).

Table 4. Breakdown of SRs between underpriced and overpriced offerings and their associated initial returns

	Underpriced IPOs		Overpriced IPOs	
SRs	No. issues	Initial returns (%)	No. issues	Initial returns (%)
$0 < SRs < 1$	2	9.01	3	−19.72
$1 \leq SRs < 5$	26	4.11	26	−9.76
$5 \leq SRs < 10$	14	16.17	3	−8.88
$10 \leq SRs < 50$	49	20.59	11	−6.54
$50 \leq SRs < 100$	20	15.00	2	−5.94
$100 \leq SRs < 200$	20	36.91	1	−32.50
$200 \leq SRs < 300$	10	41.21	0	–
$300 \leq SRs < 400$	7	58.27	0	–
$400 \leq SRs < 500$	2	97.87	0	–
$500 \leq SRs < 600$	3	80.01	0	–
$SRs > 600$	1	80.33	0	–

undersubscribed and the others are oversubscribed. In fact, 11 (24%) of the overpriced offerings have their SRs range between 10 and 50 times and one offering in this group has been oversubscribed 100 times. Such high rate of subscription in the group of overpriced offerings casts doubts over some of Rock's (1986) remarks, namely thus: 'When oversubscription occurs, it is assumed to result exclusively from large orders placed by investors who have favourable information about the prospects of an offering. This privileged sector of the market is called "the informed" ' (p. 190).

In fact, high-SRs followed by negative initial returns are two contradictory signals and can only be explained by the arrival, after the closing date but before the floating date, of new, unfavourable information. Such new information probably relates to the awareness, in the part of uninformed investors, that a given SR, high as it may be, still is below expectation, thus signalling that informed investors were not as enthusiastic about the issue as uninformed investors expected.

Allocation methods

As mentioned above, the method to be adopted for the distribution of new shares among investors is chosen only after the application deadline. Returns earned by investors from IPO investments depend very much on the allocation method. In fact, the more popular an offering is, the higher the SR and the more severe the method of allocation adopted.

During the sample period, a total of four different allocation methods were used in issues. The first is full allocation (FA), where investors receive whatever the number of shares they have applied for. The second is the scaling down of application (SC), where investors obtain an allocation but the actual number of shares received is smaller than that applied for. The third is a combination of balloting and scaling down (B/S), where investors may or may not receive an allocation.[15] Even if an allocation is obtained, the number of shares actually received will be different from that applied for. The fourth is a modification of B/S (MB/S) where no investors are left without shares,[16] thus the probability of obtaining an allocation is one. Pure balloting is becoming less common among new offerings in Hong Kong.

As shown in Table 5, only three companies (1%) have allotted to investors the number of shares they have requested (the FA method). As for the other companies, 43 (21%) use the SC method while 132 (64%) use the B/S method. The remaining 29 companies (14%) use the MB/S method. The minimum SR when the FA and SC methods were adopted is below one while that for B/S and MB/S methods is greater than or equal to one. The highest mean SR is found in offerings using the B/S method where investors may end up with no shares. Table 5 also shows that the more oversubscribed an offering is, the more severe the rationing method. Since the rationing method is linked to the rate of subscription, it is clear that demand will surely influence the level of initial returns.

The relationship between initial returns and allocation methods is also reported in Table 5. The mean return is the highest (22.57%) for new offerings adopting the combination of B/S. This is the only method where investors may receive nothing from a new offering and it is natural that these disappointed investors rush to participate in the secondary market, leading to a higher rate of initial returns. Although investors are more likely to receive new shares from offerings using either the MB/S or the SC method, earned returns (ranging from 1 to 3%) are clearly smaller than those earned where the B/S method is used. Mean returns are negative for companies using the FA method, indicating that this allotment of shares signals a nonprofitable issue.

A comparison of the two most frequently used allocation methods (SC and B/S) is also conducted. Results from both parametric and nonparametric

[15] The notation follows McGuinness (1993).

[16] For these 29 new offerings, scaling down of applications is performed first. Afterwards, using balloting of application, additional shares are allotted to investors. Thus, investors will definitely receive new shares from these offerings, but what matters is just the sizes of an allocation.

Table 5. SR and underpricing for each type of allocation methods

Cases	FA 3 (1%)	SC 43 (21%)	B/S 132 (64%)	MB/S 29 (14%)
SR				
Mean	0.5567	4.8551	98.4362	12.9138
SD	0.3011	8.6957	132.9982	23.9672
Range	0.22–0.80	0.30–50.90	1.00–658.28	1.55–180
Underpricing (%)				
Mean	−0.1104	0.0143	0.2257	0.0316
SD	0.1946	0.1534	0.3034	0.1176
Range	−0.2462–0.1125	−0.1800–0.7748	−0.3252–1.8376	−0.2447–0.2582

tests (Table 6) suggest that the two methods are dissimilar in terms of SRs and initial returns, and those differences are statistically significant. This finding is consistent with McGuinness (1993).

Probability of receiving an allotment

There are altogether 661 different application size levels in the entire sample. While some of them are present in all of the 207 new offerings, others are unique or there are relatively few offerings that have such application sizes. In order to arrive to a common set of levels, the present study conducts a frequency counting on the actual number of offerings having a particular application size level. For example, the level of 2000 new shares predominates, being used by 206 out of the 207 new offerings. After the counting, it is found that 100 application levels are quite popular among issuing companies. The remaining levels, by contrast, are used by just a few companies. This study thus concentrates on examining returns for those 100 popular levels. The maximum number of levels that may be examined ultimately depends on the size of the sample. In that respect, the study compares favourably with McGuinness (1993) where the return's behaviour of only 20 application levels is examined.

As shown in Fig. 1, the probability of obtaining an allocation increases with the size of the application. For the smallest application level, 2000 shares, this probability is just 0.5 whereas for application levels above 1 000 000 shares, it becomes one and remains there. If an investor really wants to obtain an allotment of new shares, he/she needs to apply for shares in excess of 1 000 000. In the case of underpriced offerings, the probability of receiving new shares is just 0.4 for the smallest level. When an offering is overpriced, this probability rises to 0.7. This strongly suggests a winner's curse as proposed by Rock (1986). Assuming that small investors are those identified by Rock as less informed, it is clear that small investors have indeed a greater chance of being allotted shares in an overpriced new offering than in an underpriced one. It is because of this allocation bias that small investors expect new shares to be sold at a discount.

Table 6. A comparison of two allocation method types (SC and B/S) for SRs and initial returns, for new offerings in Hong Kong

	SR	Initial returns
t-statistics	−8.032 (< 0.0001)	−5.992 (< 0.0001)
z-statistics	−8.649 (< 0.0001)	−5.265 (< 0.0001)

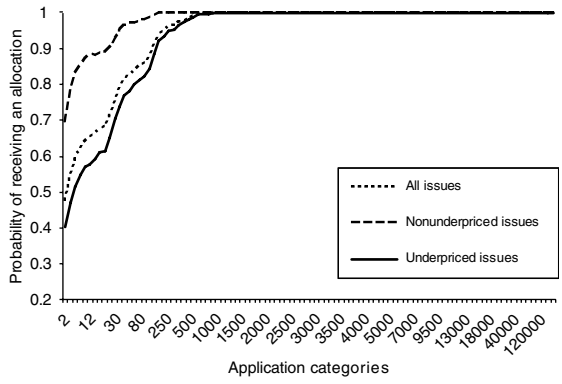

Fig. 1. Probability of receiving an allocation for each application level

Allocation-adjusted initial returns

Although an allocation bias exists, it is still worthwhile to examine the return's behaviour for different application levels. The average level of initial returns during the sample period is 16%. However, after considering rationing methods, returns range from 2.18% (for an application level of 2000 shares) to 20.85% (for 300 000 000 shares). Although the magnitude of returns differs between levels, they are all significantly different from zero. Figure 2 outlines the behaviour of the returns in relation to the number of shares applied for.

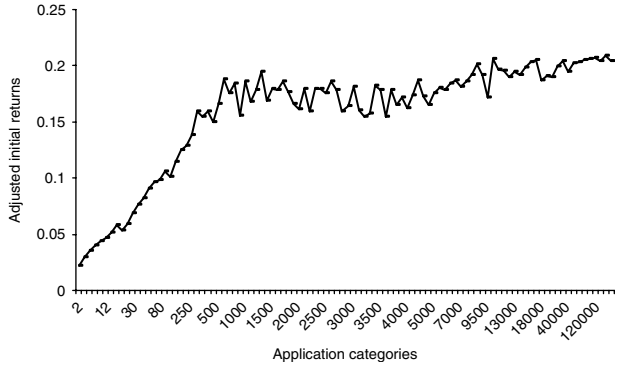

Fig. 2. Allocation-adjusted initial returns for each application level

Figure. 2 shows three distinctive patterns. For application levels of less than 500 000 shares, returns increase steadily with the size of an application. Within this range, the more an investor applies for, the more he/she receives and the higher the level of initial returns will be. The following pattern encompasses application levels from around 500 000 to 5 000 000 shares. Within this range, returns are volatile, fluctuating randomly around the same value. Starting from an application level of 5 100 000 shares onwards, returns once again increase with the size of an application although by less than that in the initial pattern. Actually, within this range, initial returns in excess of 20% are not uncommon.

A detailed analysis of these patterns is reported in Table 7. The average probability-adjusted initial return for each of the three patterns is 8.6, 17.2 and 19.5%, respectively. Since, in the first pattern, initial returns range from 2.2 to 15.9%, it is not surprising (but elusive) that its measured SD is the highest. In fact, when the observed correlation between return and the size of an application is accounted for, the ensuing SD is the smallest amongst the three patterns. As for the second pattern, corresponding to application levels between 500 000 and 5 000 000 shares, a two-digit return can be expected with SD higher than that of the third pattern. The highest returns are associated with the third pattern, corresponding to application levels over 5 000 000 shares. Large investors, probably institutional investors, are indeed capable of earning a high and quite stable return from IPOs in Hong Kong.

Figure 2 thus suggests that, in Hong Kong, the effect of application sizes on expected returns is clearly differentiated among three groups: a group of small investors that cannot afford to apply for more than 500 000 shares, a group of medium-size investors that may subscribe up to 5 000 000 shares and a group of large investors.

In order to provide evidence of the existence of the three groups of investors, a C&RT[17] algorithm is first used to breakdown application sizes according to patterns observed in the variance of returns. Breakdown values of around 500 000 and 5 000 000 shares are indeed visible, the first being highly significant whereas the second is nonsignificant. Next, three regression models are built, one for each group, where expected returns are explained by the size of applications. Results are also shown in Table 7. For the first group, the variability of returns explained by size (R^2) is high (above 80%) and both the slope and the constant term are positive and statistically significant. For the second group, both the model and its parameters are nonsignificant. For the third group, the model again becomes significant as 25% of the variability of returns is explained by size, both the slope and the constant term being positive and significant.

The practical interest of the above three models consists of establishing beyond doubt that three groups of investors do exist, corresponding to three statistically separable patterns of returns. The conclusion stems from the rejection of null hypotheses associated with the three regression models whereby three distinct sources of variability cannot be overlooked when considering the relation between expected returns and application sizes.

Transaction costs

For each of the 207 new companies studied, the average number of days between an application closure and the public listing of shares is 13 while the number of days between an application closure and the refund of application monies is just 7 days. Aside from interest costs, other costs considered by the study are, as mentioned, the fixed cost of $100 and the brokerage fee. The consideration of such costs facilitates comparison with McGuinness (1993).

After transaction costs are taken into account, average allocation-adjusted returns become much lower. For the smallest application size, such returns are now negative (−0.5%). Positive returns are earned by investors applying for 4000 shares or more. The largest average return, 9%, is earned by investors applying for 700 000 shares. All except application sizes below 8000 shares produce initial returns that are statistically different from zero. The findings are consistent with McGuinness (1993),

[17] C&RT stands for 'Classification and Regression Tree' (Breimen *et al.*, 1984), an algorithm aimed at breaking data into variance-homogeneous pieces.

except for the application size of 10 000 shares where returns are significant in this study.

After considering transaction costs, the separation between the second and the third group of investors is less pronounced. Using the same cut-off point as before, the average returns for the three groups were computed and results are indicated in Table 8. Both the three returns' patterns and variances are consistent with what was reported above but, instead of a difference in returns of approximately 2%, the mean returns for the second and the third group now converge at 7%. A test of the significance of those returns for the three groups suggests that they are all statistically significant.

Regression models where returns are explained by application sizes are again built. Results are displayed in Table 8. For the first model, over 50% of the variability of returns is explained by application sizes. The second model remains statistically nonsignificant and the third model remains highly significant. Thus the three original patterns are still present, denoting the existence of three different sources of variability and the consideration of transaction costs does not alter results.

Risk-free rate of return

As purposed by Rock (1986, p. 205) and later empirically tested by Koh and Walter (1989), when initial returns are adjusted by the probability of receiving an allotment of new shares, investors should earn just the risk-free rate of return. Therefore, in addition to adjusting returns for transaction costs, the risk-free rate is also incorporated into the empirical testing. There are now three application levels (2000, 4000 and 6000 shares) producing returns

Table 7. Allocation-adjusted returns and regression analysis for each of the three return patterns ('000)

	Application levels		
	Below 500 shares	500–5000 shares	Above 5000 shares
Underpricing (%)			
Mean	0.0855	0.1724	0.1947
SD	0.0422	0.0111	0.0100
Range	0.0218–0.1592	0.1499–0.1724	0.1719–0.2085
Regression results			
Adjusted R^2	83.4%	0%	24.6%
F-value (Sig.)	121.408 (< 0.0001)	0.666 (0.419)	11.781 (0.002)
Coefficients			
Unstandardized	0.000285	−0.000001	0.00000005
Standardized	0.917	−0.130	0.519
t-value (Sig.)	11.019 (< 0.0001)	−0.816 (0.419)	3.432 (0.002)
Constant	0.05436	0.175	0.192
t-value (Sig.)	12.216 (< 0.0001)	44.217 (< 0.0001)	109.303 (< 0.0001)

Table 8. Allocation and transaction costs adjusted returns and regression analysis for each of the three return patterns ('000)

	Application levels		
	Below 500 shares	500–5000 shares	Above 5000 shares
Underpricing (%)			
Mean	0.0421	0.0718	0.0731
SD	0.0234	0.0078	0.0055
Range	0.0050–0.0793	0.0544–0.0897	0.0614–0.0855
Regression results			
Adjusted R^2	61.9%	5.4%	20.0%
F-value (Sig.)	40.037 (< 0.0001)	3.262 (0.079)	9.265 (0.005)
Coefficients			
Unstandardized	0.000137	−0.000002	0.00000003
Standardized	0.797	−0.278	0.474
t-value (Sig.)	6.327 (< 0.0001)	−1.806 (0.079)	3.044 (0.005)
Constant	0.0272	0.0762	0.0715
t-value (Sig.)	7.280 (< 0.0001)	28.363 (< 0.0001)	72.055 (< 0.0001)

that are negative in average, indicating that, in such case, new share acquisition is not worth the effort. The smallest positive return requires an application of 8000 shares or more and the largest return is associated with an application of 700 000 shares (7.9%). Figure 3 portrays the returns' behaviour for all the application sizes. For application sizes below 30 000 shares, initial returns are not significantly different from zero. Any application below this level is in fact earning a return that is not significantly different from that of the risk-free asset.

The three patterns previously observed in the relation between expected returns and application sizes are also present after adjusting for the risk-free rate. First, returns rise with the application size. Then, from application sizes of 500 000 shares onwards, returns fluctuate randomly. Starting at an application of 5 100 000 shares, returns rise again with size, but just slightly. Table 9 shows descriptive statistics as well as regression models for the three groups.

After the adjustment for the risk-free rate, the behaviour of mean returns and SD remains unchanged for the three patterns. The minimum and maximum expected returns are associated with applications of less than 500 000 shares and over 5 000 000 shares, respectively. Large investors enjoy not only just the highest but also the most stable returns. As before, for all three groups, returns are statistically different from zero.

Consistent with previous regressions, the most significant model is associated with application levels below 500 000 shares. Within this range, initial returns increase with the application size. For applications between 500 000 and 5 000 000 shares, both the model and the coefficients are now statistically significant with returns decreasing with size. The third regression model is similar to the previous case although with another reduction in explanatory power. Since the slope of the second model, although significant, has a negative sign, the hypothesis that the three groups may have been drawn from the same population is again rejected.

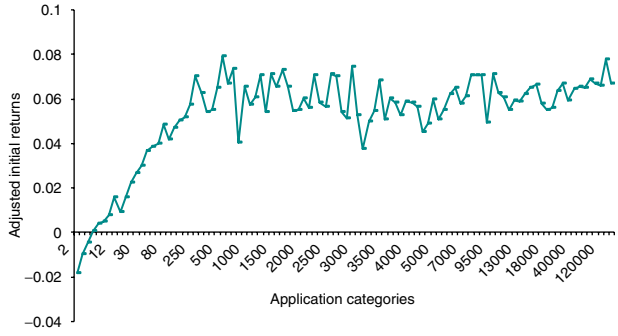

Fig. 3. Allocation-adjusted returns after the consideration of transaction costs and the risk-free rate

IV. Conclusion

Results show that investment in unseasoned equity offerings is worth an effort in Hong Kong, especially above a given application size. Indeed, even where the probability of receiving an allocation of new shares is less than one, it was found that allocation-adjusted returns may be positive and significant. After considering both transaction costs and the risk-free rate of return, results remain unchanged except for small application sizes. This finding casts doubt on the hypothesis put forth by Rock (1986) that weighting initial returns by the probability of receiving an

Table 9. Allocation-adjusted returns after subtracting transaction costs and the risk-free rate of return: statistics and regressions for each of the three patterns ('000)

	Application levels		
	Below 500 shares	500–5000 shares	Above 5000 shares
Underpricing (%)			
Mean	0.0281	0.0597	0.0628
SD	0.0246	0.0095	0.0062
Range	−0.0182–0.0704	0.0374–0.0792	0.0499–0.0776
Regression results			
Adjusted R^2	64.9%	13.9%	17.3%
F-value (Sig.)	45.333 (< 0.0001)	7.434 (0.010)	7.918 (0.008)
Coefficients			
Unstandardized	0.000148	−0.000003	0.00000003
Standardized	0.815	−0.400	0.445
t-value (Sig.)	6.733 (< 0.0001)	−2.762 (0.010)	2.814 (0.008)
Constant	0.0120	0.0674	0.0611
t-value (Sig.)	3.187 (0.004)	21.534 (< 0.0001)	53.867 (< 0.0001)

allocation should leave uninformed investors earning the risk-free rate (p. 205). Actually, an application in excess of just 30 000 shares may produce initial returns that are significantly different from the risk-free rate and it is not impossible, even for small investors, to purchase 30 000 shares or more (HK$30 000–60 000 as most new offerings are priced within the range of HK$1 and HK$2).

Another finding of the study is that, in IPOs listed in Hong Kong, the relation between expected returns and the size of an application contains three distinct patterns affecting small, medium-size and large investors, respectively. A group of investors (probably, the younger) who apply for less than 500 000 shares, faces a type of return to size relationship strongly dependent on size: the more shares an investor applies for, the best he/she will do in average. A second medium-sized group of investors (probably white collar) gets a rather stable (but uncertain) type of return pattern irrespective of the size of the application. At this level, IPOs are worth the effort in average. Finally, the group of the largest investors (probably institutional investors) gets a type of return pattern which is again correlated to the size of the application and less volatile than the previous pattern. Here is where the best rewards for IPOs can be earned.

The order and significance (or lack of it) of the three regressions lead to the rejection of the null hypothesis that the observed patterns stem from occasional randomness. Consequently, there are three instead of two groups of investors in Hong Kong and it is likely that such groups may correspond to the least informed, the median informed and the most informed. Results thus suggest that the Rock (1986) model, capable as it is of providing a broad picture describing the behaviour of investors in IPOs, fails to capture some important details. The use of a large sample, in a specially adequate test bed as is Hong Kong, has allowed this study to highlight some of such anomalies and to offer explanations for their existence.

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