Allocations, Adverse Selection and Cascades in IPOs
Evidence from the Tel Aviv Stock Exchange

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Abstract

Three major theories of IPO underpricing are examined, using unique data from Israel where the allocation to subscribers is by equal proration. This enables to simulate the return earned by uninformed investors. Consistent with Rock's (1986) theory of adverse selection, allocations were negatively related to underpricing. However, uninformed investors earned a *negative allocation-weighted excess return*, although the average IPO excess return was 12%. Welch's (1992) theory of information cascades is supported: demand is either extremely high or there is undersubscription, with very few cases in between. Also supported is the proposition that underpricing is a means to increase ownership dispersion.

1. Introduction

Stocks issued in IPOs appear to be underpriced: they earn an average positive return immediately following the IPO. This phenomenon has been documented in many countries.[1] This paper tests three major theories of underpricing in IPOs by using data from the Tel Aviv Stock Exchange (TASE), which make these tests feasible. These data also enable to study the excess demand for new issues, its determinants and its relationship to underpricing.

Rock (1986) proposed that the high positive returns that are observed in IPOs cannot be earned in practice because of adverse selection. Uninformed investors are allocated greater quantities in overpriced IPOs and smaller quantities in underpriced IPOs. This is because investors who are informed about the issuing company's value select to invest in underpriced IPOs. Underpricing is then needed to attract uninformed investors. In equilibrium, "weighting the returns by the probabilities of obtaining an allocation should leave the uninformed investor earning the riskless rate" (Rock (1986), p. 205).

We test this statement using data from the TASE, which enables to calculate the allocation-weighted returns to IPO investors. The data are the rate of allocation to investors relative to their subscriptions. In the TASE, in case of oversubscribed IPOs, securities were allocated by *equal proration* to all subscribers, each receiving an equal fraction of his or her subscription. The allocation rate was publicly announced at the end of the IPO day. This enables us to simulate the initial return that would be earned by *uninformed* investors and to examine whether allocations are related to underpricing. In contrast, in the U.S., the allocation rate to subscribers in IPOs is at the discretion of underwriters and brokers and varies across subscribers. Therefore, these tests cannot be done in the U.S.

Using the data on the rate of allocation to subscribers, we test Rock's (1986) theory in two ways:

(i) We test for adverse selection by examining whether the allocation rate to subscribers was greater in overpriced IPOs.

(ii) We simulate the excess return that would be earned by *uninformed* investors by calculating the *allocation-weighted* excess return that would be earned by an investor who participated equally in all IPOs (or randomly in some IPOs).

Consistent with Rock (1986), we find evidence of adverse selection in IPOs. However, uninformed investors earned a small *negative* excess initial return, even though the average IPO excess initial return was 12%. This means that IPOs were slightly *overpriced* for uninformed investors. Still, investors whom we call *partially informed* could do better and earn zero excess return, as proposed by Rock (1986). Investors who were uninformed about the issuing firm could use publicly available information about the market and participate selectively only in IPOs that were preceded by high market return or low volatility.

The second theory that we examine is that of information cascades or herding in IPOs, due to Welch (1992). If investors learn about the value of the issued company by observing the behavior of other investors, issues will underprice their stock to create a cascade or herding of buyers. We find that investors either subscribed overwhelmingly to new issues, which resulted in very small allocations, or largely abstained so that the issue

[1] See Loughran, Ritter and Rydkvist (1994), Ritter (1998), Jenkinson and Ljungqvist (2001).

was undersubscribed and subscribers received full allocation, with very few cases in between. This is consistent with herding.

Thirdly, we examine the theory that underpricing is a means to increase ownership dispersion after the IPO, as proposed by Booth and Chua (1996) and by Brennan and Franks (1997). We find that greater underpricing is associated with a larger number of accepted subscriptions in the IPO, controlling for the firm's size.

Underpricing in IPOs was also explained by price stabilization or price support by underwriters after the IPO (Hanley et al. (1993), Ruud (1993), Schultz and Zaman (1994)). This explanation, however, does not apply in our case since price support by underwriters is not allowed on the TASE.

In the U.S., Rock's (1986) winner's curse theory was tested indirectly under the assumption that institutional investors are better informed. Michaely and Shaw (1994) showed that in IPOs with small participation of institutional investors, underpricing is smaller since then investors know that they do not have to compete with informed investors. Aggrawal, Prabhala and Puri (2001) used data on the proportion of the issue that is allocated to institutional investors and retail investors. They found that institutional investors received larger proportion of new issues in IPOs that were more underpriced, and that they earned more than retail investors, avoiding "lemons" in the IPO market. However, in the U.S. there are no data on the allocation rate to subscribers relative to their subscriptions.[2] Therefore its is impossible to test Rock's (1986) proposition that although IPOs are underpriced, uninformed investors earn zero excess return.

[2] Our allocation data are different from those in Aggrawal et al (2001). Our allocation is the proportion of each subscriber's order that is filled in the IPO. Their allocation is the proportion of each issue that is allocated to a type of investor (institutional or retail). The same data were also used by Ljungvist and Wilhelm (2001) who found, using 3SLS estimation, that underpricing is negatively related to the allocation

Rock's (1986) theory was examined in countries where there were data on allocation to subscribers, but the results are not conclusive. The results were inconsistent among these studies: in two studies the return was decreasing in order size (in one, the relationship is non-monotonic) while in one it was increasing in size. In addition, there were some problems with the allocation procedure in IPOs in these countries that were absent in Israel.

Koh and Walter (1989) studied 66 IPOs in Singapore during 1973-1987. There, allocation to subscribers was done by "combinations of full allocation, pro-rata allocation and balloting" (p. 268) with the selection of an allocation basis done by the issuer after the IPO. The probability of allocation was a non-monotonic decreasing function of the order size. They found that the IPO return, adjusted for allocation, was positive but insignificantly different from zero. It was higher for small orders and lower for larger ones, with the return-order size relationship being non-monotonic, having a saw-teeth pattern that reflected the allocation method. Levis (1990) analyzed 123 IPOs during 1985-1989 in the UK, where issuers had discretion as to the method of allocation as a function of the order size, involving ballot or rationing or both. Rationing "may involve any form or pattern that suits the particular circumstances" (p. 78). Then, "the probability that an investor obtains a specified number of shares, … is proportional but not always linear to the size of the application" (p. 78). The average return, adjusted for allocation, was positive and statistically significant. The return was increasing in the order size and then decreasing for larger orders, being insignificant for the largest orders above 2 million pounds. (This was calculated using estimates on the probability of obtaining

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to institutional investors, since by their model there is substitution between the amount that these investors receive and the extent of underpricing on this amount.

certain number of shares at a specific level of application.) Keloharju (1993) studied 80 cases of IPOs in Finland during 1984-1989, where the allocation was a function of the order size with the formula of allocation being set ex post. He found that the allocation-weighted excess return was a declining function of the order size, being positive for small orders and negative for large orders.

In these studies, the uninformed investors' returns were affected by their order placement strategy since the allocation was a function of the order size and its method (balloting or rationing or a combination of both) was sometimes determined ex post. This makes it difficult to simulate the strategy for uninformed investors. In addition, in Finland, investors could be effectively excluded from participating in IPOs that garnered high demand: the acceptance of new orders could be stopped at any time before the IPO day by the management of the issue, after learning that the issue has been fully subscribed. (Indeed, subscriptions to IPOs were often discontinued before the closing day of the offering.) And, payment was done one or two months after the first day of issue, which raised the effective return due to the time value of money. Finally, the reliability of rationing data in Finland was varying.

In contrast, in the TASE the rate of allocation to subscribers was simply proportional to their order size[3] and every investor who wished to participate at the IPO could subscribe at any time during the IPO day. This enables us to simulate the returns earned by uninformed investors and test Rock's (1986) propositions on the return-allocation relationship.

[3] Except in four cases during the period 11/1989-11/1993, 1.4% of the sample, in which allocations was a decreasing function of the quantity ordered by investors.

In what follows, section 2 describes the data and the main variables – excess return and allocation – and their determinants. Section 3 presents two tests of Rock's (1986) theory: section 3.1 provides a test of the existence of adverse selection in IPOs, and section 3.2 provides evidence on the excess return earned by uninformed investors. Section 4 analyzes the performance of uninformed investors who can condition their participation on publicly-available information. The theory that relates underpricing to ownership dispersion is tested in Section 5. Section 6 presents the conclusions.

2. Data, underpricing and allocation

The study includes 284 IPOs in the Tel Aviv Stock Exchange between 11/1989 and 11/1993, after which time the IPO method has changed.[4] Table 1 includes information about our sample. Most IPOs – 84.6% – were of units, a bundle of stocks and warrants or bonds (mostly convertible) or both, which were sold together but were separable right after the IPO.

INSERT TABLE 1

Issues were sold either at a fixed predetermined price or at a price that was determined in a sealed-bid, uniform-price auction with specified minimum and maximum prices. Auction was by far the preferred method: it was used in 86% of the IPOs. In auctions, investors submitted sealed bids specifying a quantity and a price within the given range (including the upper and lower bounds). Most auctioned IPOs were effectively fixed-price IPOs: 77% of auctioned IPOs closed at the maximum price, which ended up being the issue price, and the allocation among subscribers was done by equal

[4] In 12/1993, it was mandated that *all* IPOs be auctioned with no maximum prices; see Kandel, Sarig and Wohl (1999).

proration to all. When the equilibrium price was below the maximum, subscribers at the maximum price received the full quantity they had ordered and paid the equilibrium auction price.

The unit price or the auction minimum and maximum prices were stated in the prospectus, which was published one week (five business days) before the IPO day. The offer price could not be revised between then and the IPO day. There were neither road shows nor a bookbuilding process. On the IPO day, subscriptions were received by brokers from morning till noon and passed on to the underwriter. The results were announced immediately thereafter. To guarantee the integrity of the orders, a subscriber had to deposit with her broker the full amount of her subscription on the day of the IPO.

The scenario seems to bear close resemblance to that assumed in Rock's (1986) model. Our simulation of an uninformed investor assumes subscribing for a fixed amount in each and every IPO. The subscription price was either the fixed issue price or, in case of an auction, the auction's maximum price. This would guarantee the investor to be apportioned some units in *all* IPOs. Bidding below the maximum price would have excluded the investor from about three quarters of auctioned IPOs that closed at the maximum price.

2.1 Underpricing

Trading in the stock commenced on the day after the IPO day, and trading in the other securities that were included in the unit usually commenced three days after the IPO. Securities issued in IPOs traded by a once-a-day auction, called *Karam*, that was used for small-cap securities. Under this trading method, securities prices were more noisy and adjusted more slowly to information than in a continuous trading market (see Amihud, Mendelson and Lauterbach (1997)). We therefore measure the initial IPO return six days after the issue day, which are two or three days after the warrants and bonds in the unit started trading. The initial six-day excess return on the IPO unit of securities of firm *j*, is

(1) $ER_j = P_{j,6} / P0_j - M_{j,6} / M_{j,0}$.

$P_{j,t}$ is the market price of unit *j* on day *t*, day 0 being the IPO day, and $P0_j$ is the unit's offer price. The post-IPO unit price is the sum of the market prices of its components (of the securities that make up the unit).[5] $M_{j,t}$ is the closing price of the TASE *Karam* market index on day *t* relative to the IPO day of firm *j*. This index is the proper benchmark for IPO securities since it included securities with relatively small float, similar to the newly issued securities. Longer-term excess returns are calculated over 15 and 150 days[6] after the IPO:

(2.1) $ER15_j = P_{j,15} / P0_j - M_{j,15} / M_{j,0}$.

and

(2.2) $ER150_j = P_{j,150} / P0_j - M_{j,150} / M_{j,0}$.

INSERT TABLE 2

INSERT FIGURE 1

Statistics on excess returns in IPOs are presented in Table 2 and the distribution of the initial excess return, ER_j, is depicted in Figure 1. The average ER_j is positive and significant: the mean is 11.99% with t = 7.20. Two third of the returns (66.6%) are

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[5] For example, if the unit of firm *j* included one share of stock and two warrants, $P_{j,6}$ would be the share price plus twice the warrant price.
[6] The time period after the IPO is limited to 150 days because later there were expirations of warrants and convertible bonds, which were included in most of the IPOs.

positive; this proportion is significantly different from a chance result of 50% (t = 5.58). The average 15-day and 150-day excess returns, $ER15_j$ and $ER150_j$, are slightly higher, 13.14% (t = 6.77) and 15.00% (t = 4.16), respectively. Notably, the mean excess return from day +6 to day +150 is not significantly different from zero (mean = 2.95%, t =1.10), which implies that there is no momentum effect in pricing. Nor does the initial excess return ER_j show evidence of overshooting that is subsequently reversed: the correlation between ER_j and the subsequent excess return over days +6 to +150 is very small, –0.028, insignificantly different from zero. This evidence shows that the market priced the issued units efficiently immediately after the IPO, and that the IPO excess return was not a result of fad or overreaction.

2.2. Allocation

Testing Rock's (1986) theory requires data on "the probabilities of obtaining an allocation" (p. 205) in IPOs. These data, which are unavailable in the U.S., are available in Israel. There, the allocation was an equal proportion to all subscribers and it was publicly announced at the end of the IPO day. The allocation rate to subscribers was simply the ratio of the number of units issued to the number of units subscribed by investors, so that each subscriber received the same proportion of his or her order. The allocation rate was naturally not greater that 1.0 when the issue was undersubscribed, in which case the underwriter absorbed the unsold quantity.[7] $ALLOC_j$ denotes the allocation rate in IPO j, $0 < ALLOC_j \leq 1$.

[7] In the four IPOs where allocation was declining in order size, $ALLOC_j$ is the ratio of issued units to the quantity subscribed. Excluding these four observations does not change the results in any meaningful way.

INSERT TABLE 3

INSERT FIGURE 2

Statistics for $ALLOC_j$ are presented in Table 3, and the pattern of its distribution is shown in Figure 2. The distribution of $ALLOC_j$ is an extreme U-shaped distribution that is skewed to the left. While the mean $ALLOC_j$ is 0.360, the median is far lower, 0.048. The allocation in most IPOs was extremely small due to overwhelming oversubscription, and in many cases there was undersubscription at the offer price or at the auction maximum price, resulting in $ALLOC_j = 1.0$.

The distribution of $ALLOC_j$ is consistent with the implications of Welch's (1992) model of information cascades. There, each investor has a prior belief about the true value of the IPO, which is revised after having observed the offer price and whether other investors subscribe or abstain. Based on that, the investor then decides on whether to subscribe to the IPO. Since one investor's decision is influenced by that of others, there is herding into subscribing or abstaining. As a result there is either overwhelming oversubscription or undersubscription. Figure 2 indeed shows evidence of very high demand or abstention, with only a few issues in between these extremes.

The U-shaped distribution of the allocation could also be obtained if underwriters simply erred in setting the offer price compared to what investors considered the right price. An error in either direction of the price that investors assessed for the issued securities would cause demand by investors to bunch at either ends of the allocation segment, i.e., either at 1 in overpricing or close to zero in underpricing.

2.3. The determinants of underpricing and allocation

If underpricing is done just to the extent necessary to attract sufficient demand to accommodate some observed factors, there should be no relationship between *excess* demand and these factors. Our data on the rate of allocation, which measures excess demand, enables us to examine this issue. We find that excess demand was predictable by factors that were publicly known before the IPO, and that factors that led to greater underpricing also led to greater excess demand. This means that underpricing was done to a greater extent than was necessary to attract sufficient demand.

The following are the variables that are likely to affect the IPO excess return and the demand for IPO units.

(i) *The market's past returns*. If underwriters fully adjust the offer price to market conditions, the market return before the offer price is set should not affect underpricing. Lowry and Schwert's (2001), however, found that the evolution of the offer price before the IPO reflects a partial adjustment to recent market returns. In Israel, the pricing decision of the IPO was made by the time that the prospectus was submitted, five or six days before the issue day, with no revision thereafter.[8] We therefore consider the market return before the offer price was set, the ten-day period -16 to -6,

(3) $RM6\text{-}16_j = M_{j,-6}/M_{j,-16} - 1,$

where $M_{j,t}$ is the TASE *Karam* market index. We also consider the five-day market return between the price setting day and the IPO day, days -6 to -1 (day -1 is the last full day with information about the market before investors entered their orders on day 0),

(4) $RM1\text{-}6_j = M_{j,-1}/M_{j,-6} - 1.$

[8] Issuers could withdraw the prospectus and cancel the IPO, but it was extremely rarely done.

RM1-6$_j$ should positively affect ER_j since this market return occurred after the setting of the issue price. But *RM6-16*$_j$ should have no effect on ER_j if this information about the market were fully incorporated in the pricing of the IPO.

(ii) $PROCEEDS_j$ is the logarithm of the IPO proceeds or the issue size in monetary units (Israeli Shekels, in constant prices of December 1992). If we liken the IPO to a block sale, it is expected that larger issues are underpriced more in order to attract sufficient demand.[9] On the other hand, if larger issue size means smaller uncertainty (Beatty and Ritter, (1986)), it should have a negative effect on underpricing (see next).

(iii) $SDER_j$ is the standard deviation of the daily excess return in the after-market, days +6 to +15. This proxy for the uncertainty about the value of the issued securities was proposed by Ritter (1984), who found that it has a positive effect on underpricing. Theory predicts that underpricing is positively related to uncertainty. Rock (1986, p. 189) stated: "the greater the uncertainty about the true price of the new shares, the greater the advantage of the informed investors and the deeper the discount the firm must offer to entice uninformed investors into the market." Beatty and Ritter (1986) proposed that because the informed investor faces a payoff that resembles a call option, greater uncertainty induces more investors to spend resources and become informed. Then, more uncertainty increases the asymmetry in information and requires greater underpricing to attract uninformed investors. Welch (1992) proposed that underpricing is an increasing function of a mean-preserving increase in the spread of investors' prior beliefs about the IPO price. We also examine here the effect of uncertainty on excess demand, measured by the allocation rate.

[9] Kraus and Stoll (1972) showed that large block sales were associated with a temporary liquidity discount.

(iv) $AUCTION_j$ = 1 for IPOs sold by the auction method with upper and lower price limits, and 0 for IPOs sold at a fixed price. Because the auction had an upper price limit, it effectively became a fixed price method when that limit was binding and then rationing was necessary. This occurred in 77.1% of the auctions (see Table 1). Yet, in auctions an equilibrium price could be reached below the maximum price without a need for the underwriter to absorb the unsold quantity. Therefore, underwriters could set higher maximum prices than they would in fixed-price IPOs since their risk of undersubscription was lower.[10] As a result, underpricing is expected to be smaller in IPOs by auction. While evidence shows that IPO underpricing is smaller in countries where auctions are used (Loughran, Ritter and Rydkvist (1994)), this is the first study that compares the effects of the two methods of IPOs within the *same* market.

(v) $UNIT_j$ = 1 in an IPO where a unit of securities is issued, and $UNIT_j$ = 0 in an IPO of stock alone. In our sample, unit IPOs included stock and warrants or bonds (mostly convertible) or both and constituted about 85% of the cases. The decision to issue a unit of securities instead of stock alone is affected by agency costs and incentive issues (Schultz (1993)), but it may also be affected by marketing considerations. In response to our inquiry, underwriters said that it was "easier" to sell units that included warrants and convertibles, meaning that they could issue the securities at higher prices.

The effects of these variables are examined in regression models where the IPO excess return, ER_j, and the allocation rate $ALLOC_j$ are functions of the pre-IPO market returns $RM1\text{-}6_j$ and $RM6\text{-}16_j$, the issue size $PROCEEDS_j$, the method of sale $AUCTION_j$,

[10] We examined the determinants of the selection of the issuing method (single price or auction) by a Probit model, the explanatory variables being $PROCEEDS_j$, $SDER_j$ and $RM6\text{-}16_j$. These variables had no significant effect.

the uncertainty $SDER_j$ and the composition of the issued unit $UNIT_j$. In the allocation model we use $ALLOCT_j$, the logistic transformation of the allocation rate:

(5) $ALLOCT=log(ALLOC+a)/(1+ALLOC+a)$,

where a= ½/284, to accommodate the cases where $ALLOC$=1 or is practically zero.[11] The estimation results of these models are presented in Table 4.

INSERT TABLE 4 HERE

The results show that the factors that led to greater underpricing also stimulated higher demand and brought about smaller allocation: the signs of the coefficients in one model are the opposite of their signs in the other model. This may suggest that underpricing was greater than necessary to ensure a given level of (excess) demand. An exception is the type of unit, $UNIT_j$, whose effect is insignificant in the allocation equation (therefore it is not included in the final estimation of the allocation model).

It is expected that $RM1\text{-}6_j$ should affect both underpricing and excess demand (allocation). Since the offer price was set by day -6, it was already stale by the IPO day. Therefore, the change in market prices during the last six days before the IPO should have affected the demand for the issue. However, the significant coefficients of $RM6\text{-}16_j$ in both equations imply that underwriters deliberately underpriced IPOs relative to information they had before the IPO about market returns during days (-16, -6). This is consistent with Lowry and Schwert’s (2001) observation of partial adjustment of the offer price to recent market returns. Notably, underpricing was not affected significantly by the market return in the preceding 10-day period, days (-26, -16), suggesting that this information about the market was fully incorporated into the offer price.

INSERT TABLE 5 HERE

We observe that IPOs were timed to take place after an unusual rise in market prices. The average daily return during days (-26, -16) was 2.36 times the return after the IPO, days (0, +10), and the return during days (-16, -6) was 56% greater than the return on days (0, +10). The return since the IPO price was announced in the prospectus, days (-6, -1), was practically the same as the return on days (0, 10). That is, issuers did not have any predictive power regarding the return between the prospectus day and the IPO day, but they timed the IPO after a period of an unusually high market price run-up.

Doing IPOs after a rise in market prices enabled issuers to raise their offer price and raise more money. The partial adjustment of the offer price to the recent market return $RM6\text{-}16_j$ is consistent with Loughran and Ritter's (2001) proposition, based on prospect theory, that issuers do not mind "leaving money on the table" when the IPO brings them higher value than they have anticipated. While Loughran and Ritter's (2001) analysis was in the context of the information about demand that is revealed in the pre-IPO bookbuilding process,[12] we apply it here to information about the recent market return (in Israel, there is no bookbuilding process).

Underpricing was greater for IPOs that were larger and had greater uncertainty. Such IPOs also had greater excess demand, as measured by allocation. This means that new issues were underpriced by more than was necessary to offset the negative effects of large size and uncertainty. This indicates deliberate underpricing.

Auctioned IPOs were associated with smaller underpricing, which explains the popularity of this method (see Table 1). Indeed, the auction method (without setting an

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[11] See Cox (1970), p. 33.

[12] Loughran and Ritter's (2001) proposition explains the phenomenon, documented by Hanley (1993), about underpricing being larger when the offer price is moved upward following the bookbuilding process.

upper price limit) was mandated by the Israeli Securities Authority in December 1993. As expected, this reduced underpricing (Kandel et al. (1999)). The smaller underpricing also reduced the excess demand in auction IPOs.

Finally, underpricing was smaller in IPOs of units of securities that included, in addition to stock, warrants or bonds or both.[13] This is consistent with the underwriters' claim that unit IPOs are "easier" to sell.

Underpricing does not necessarily imply gains to uninformed investors since. Rock (1986) suggested that greater excess returns are offset by smaller allocations of shares to investors and uninformed investor should realize a zero excess gain. This is examined in the next section.

3. Two tests of Rock's theory

3.1. Test I: adverse selection

Rock's (1986) hypothesis of adverse selection (or winner's curse) in IPOs implies a negative correlation between IPO initial returns and allocations to investors. Since informed investors avoid overpriced IPOs, uninformed investors then receive larger allocations of shares on which they earn negative returns. In underpriced IPOs that earn positive returns, uninformed investors receive smaller allocation.

Consistent with Rock's (1986) proposition of adverse selection in IPOs, we obtain the following relation:

(6)	$ER_j =$	0.093	$-$ 0.028 $ALLOCT_j$	
	(t statistic)[14]	(6.62)	(9.07)	$R^2 = 0.225$

Benveniste and Spindt (1989) explained that underwriters do that to elicit truthful information from investors during that process.

To examine whether the results are affected by extremely high allocations, we excluded observations where $ALLOC_j > 0.95$ (25.7% of all IPOs). For the remaining 211 IPOs, the results are:

(6')	$ER_j =$	0.033	$- 0.044\ ALLOCT_j$	
	(t statistic)	(1.56)	(6.74)	$R^2 = 0.136$

The results thus strongly support the existence of adverse selection in IPOs.[15]

Another examination of the adverse selection proposition is presented in Table 3, where the sample divided between overpriced and underpriced IPOs. In *overpriced* IPOs (where $ER_j < 0$) the average allocation rate is 0.613 whereas it is much less than half, 0.232, in *underpriced* IPOs (where $ER_j > 0$). The difference between the medians is much greater: allocation of 0.920 in overpriced IPOs vs 0.013 in underpriced ones. This strongly supports the proposition of adverse selection in IPOs.

While the results are consistent with Rock (1986), the negative relationship between IPO initial returns and allocations can also be obtained under a simpler scenario. If underwriters set the offer price different from what investors believe it should be – say, due to error in estimating the market's expectations -- we shall observe a negative relationship between IPO initial returns and allocations. When the offer price is smaller than the market's expectation of the company's value there will be excess demand (low allocation) and high return, and the opposite will occur when the offer price is above the market's expectation.

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[13] Underpricing was not significantly affected by whether the additional securities in the unit were warrants or bonds or both.
[14] The t statistics are calculated using White's (1980) robust standard errors.
[15] Koh and Walter (1989), Levis (1990) and Brennan and Franks (1997) found a positive relationship between oversubscription and underpricing.

3.2. Test II: allocation-weighted excess returns

Rock (1986) proposed that in equilibrium, the excess return should be zero to uninformed investors in IPOs who are subject to adverse selection. To test this proposition, we assume that uninformed investors subscribe a fixed amount for each and every IPO (or subscribe randomly to some IPOs). Their allocation-weighted excess return is given by

(7) $ERAW_j = ALLOC_j \times ER_j - interest$.

ER_j is the IPO excess return over days 0 to +6 (defined in (1)), $ALLOC_j$ is the allocation received in the IPO by equal proration to all subscribers, and $interest_j$ is the one-day interest rate[16] that prevailed at the time of the IPO of company j. This is because investors subscribing to an IPO had to deposit for one day the entire amount of their order, to ensure that they can buy the number of units ordered at the specified price.

INSERT FIGURE 3

The statistics for $ERAW_j$ are presented in Table 2 and depicted in Figure 3. The mean $ERAW_j$ is negative, −1.18%, with t = 1.77, marginally significant.[17] The median of $ERAW_j$ is practically zero. The distribution of $ERAW_j$ is negatively skewed, affected by the “lemons” where the return was negative and investors were allocated a larger proportion of their order (sometimes -- the full amount of their order), which gives the negative returns greater weight. The 15-day allocation-weighted excess return, *ERAW15*, has a mean of −1.77% with t = 2.41, statistically significant. The long-term allocation-

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[16] We use the interest rate for withdrawals from bank accounts (source: Bank of Israel report, various issues). The practice was that banks, which are by far the largest brokers in Israel, provided the funds for the one-day deposit. In the sample, the average one-day interest rate was 0.00054.

[17] An alternative formulation of the allocation-weighted excess return is $ERAW_j^M = ALLOC_j \times ER_j - M_{j,0} / M_{j-1}$ which means that instead of borrowing the money for one day (shorting a bond), investors borrowed stock (shorted the market) for one day. The results are similar: the mean of $ERAW_j^M$ is −1.17% with t = 1.75.

weighted excess return for 150 days after the IPO, *ERAW150*$_j$, has a mean of −2.43% with t = 1.52.

The conclusion is that the allocation-weighted excess return at IPOs, earned by uninformed investors, is negative. This means that *uninformed investors lose* on average, which is inconsistent with Rock's (1986) prediction. That is, IPOs are *overpriced* from the viewpoint of uninformed investors.

4. Gains from conditioning IPO subscription

Investors who were uninformed about the values of the issuing firms were assumed here to subscribe to all IPOs, or subscribe randomly to some of them. In doing so, these investors realized a small loss, which is inconsistent with Rock's (1986) prediction. The question is whether uninformed investors could improve their performance by conditioning their subscription on publicly available information that is unrelated to the firm's value. The following shows examples of this strategy.

4.1. Conditioning on past market returns and volatility

Investors could use publicly available information about the market conditions prior to the IPO that includes market return and market volatility. We examine the effect of this information as follows. Over the fifteen-day period before the IPO we measure

(i) *RM1-16*$_j$, the market return (using the *Karam* index), days -16 to -1, and

(ii) *SDRM*$_j$, the standard deviation of the market return, days -16 to -1.

We then estimate the effects of these variables is on the allocation-weighted excess return by the following models:

(8.1) $ERAW_j = -0.0248 + 0.432 \cdot RM1\text{-}16_j$
(*t* statistic) (2.87) (3.33) $R^2 = 0.031$,

and

(8.2) $ERAW_j = 0.0291 - 4.024 \cdot SDRM_j$
(*t* statistic) (1.61) (2.34) $R^2 = 0.025$.

The results suggest that investors in IPOs could increase their allocation-weighted return by subscribing only to IPOs that were preceded by favorable market conditions: high market return or low market volatility. This is also seen in the following test. In IPOs that were preceded by *RM1-16* above its median, investors broke even: mean $ERAW_j = 0.0086$ ($t = 1.11$). However, in IPOs with *RM1-16* below its median, investors lost: mean $ERAW_j = -0.0320$ ($t = 3.04$). The difference between the two means is significant ($t = 3.10$). It follows that there is a significant loss from investing in IPOs after the market has under-performed, whereas investing in IPOs that are preceded by over-performing market led to zero excess return.

Market uncertainty, measured by $SDRM_j$, had negative effect on investors' earnings, but this effect was weaker. When both measures of market performance, $RM1\text{-}16_j$ and $SDRM_j$, are included in the same model, market return emerges as the one with the stronger effect (the correlation between the two measures is –0.45).

Conditioning subscription to IPOs on other variables did not affect investors' performance. We added to model (8) the variables $PROCEEDS_j$, $AUCTION_j$ and $SDER_j$ that are included in the underpricing model. While these variables affect the excess return ER_j, they also affect $ALLOC_j$ in the opposite direction, and on balance they have no significant effect on the allocation-weighted excess return $ERAW_j$. The absence of a significant effect of $SDER_j$ on $ERAW_j$ means that investing in riskier IPOs did not yield a higher risk premium, as might be expected for risk averse investors.

It thus seems that Rock's (1986) equilibrium, in which uninformed investors earn zero excess return, applied to *partially* uninformed investors. These investors, while being uninformed about the issuing firm, could use publicly available information about the market condition before the IPO to avoid under-performing IPOs. The use of this information, which was available costlessly, could erase the small loss that would be incurred if they subscribed indiscriminantly to all IPOs (or to some of them at random).

4.2. Conditioning on allocation

Subscriptions to IPOs had to be entered on the IPO day from morning till noon. While no information was available during the day on the accumulated orders, many investors could obtain coarse information about it by talking to other investors and to their brokers who observed the order flow at their post. If investors could choose to participate in IPOs conditional on the flow of orders entered by other investors, the scenario would resemble the one described by Welch (1992), which causes information "cascades."

Was the information about the extent of the pre-IPO demand valuable? The evidence is that $Corr(ERAW_j, ALLOCT_j) = -0.215$, statistically significant. However, this relationship is driven the cases of undersubscribed IPOs ($ALLOC_j = 1$) which constitute 22% of the sample (63 cases). Excluding these IPOs, we obtain $Corr(ERAW_j, ALLOCT_j) = 0.005$. While for the undersubscribed IPOs the mean $ERAWj$ is –0.0663 (t = 2.40), for the rest of the IPOs the mean $ERAWj$ is 0.0037 (t = 1.34), insignificantly different from zero. Thus, investors that were uninformed about the issuing firm could break even by avoiding IPOs with low investor interest if they had this information; the exact extent of demand beyond that was not valuable. In fact, this is expected in an efficient market where rational investors enter orders, based on their information, up to the point where the information cannot be profitably exploited. Still, the puzzle is why informed investors subscribed early and disclosed their information about the IPO, when they did not benefit from that while inducing more demand that diluted their gain.

Since demand begets additional demand, the question is what prevents an unstoppable cascade of demand. Welch's (1992) model limits investors' purchase to no more than one share. Here, the cascade was bounded by the requirement that investors deposit the entire monetary value of their subscriptions for one day, which entails an interest cost, $interest_j$ (see (7)). This cost offsets the gain in IPOs with very small allocation (high demand) and thus discourages subscribing to them. We estimate the relationship between investor gain and allocation for half the sample (142 IPOs) for which $ALLOC_j < 0.0478$ (the median):

(9)	$ERAW_j$ =	0.0065	+	$0.0012 \cdot ALLOCT_j$	
	(t statistic)	(4.24)		(4.09)	$R^2 = 0.174$

The results show that the higher was the demand and the smaller the allocation, the smaller was the gain. This is also depicted in Figure 4, which plots the relationship between the allocation and the allocation-weighted excess return $ERAW_j$ for IPOs with allocations below the median. And given that the gain in the case of small allocation was practically nil, considering the fixed cost of time and effort involved in subscribing to an

IPO means that investors who knew the extent of demand would be better off avoiding the very hot IPOs altogether.

INSERT FIGURE 4 HERE

5. **Underpricing as a means to increase ownership dispersion**

While issuers receive smaller proceeds in underpriced issues, they may then ration the quantity among subscribers, favoring smaller investors and increasing the ownership dispersion. The issuers' gain from broader ownership is explained in two ways. Booth and Chua (1996) proposed that larger investor base increases the stock liquidity in the secondary market, which in turn lowers the firm's cost of capital and increases its value. Indeed, Amihud, Mendelson and Uno (1999) showed that an increase in the number of shareholders increases stock liquidity and stock price. Brennan and Franks (1997) proposed that diffused ownership is preferred by managers who are averse to being monitored by large shareholders.[18]

We test the hypothesis that *underpricing increases the investor base immediately after the IPO*, even when issuers do not do discretionary rationing among investors. While underpricing is known to increase demand for the stock (see (6) above), greater demand can come in two ways: (a) larger order size by investors, and (b) more investors subscribing to the IPO. Since in Israel issuers had no discretion in allocating shares to subscribers, underpricing could increase ownership dispersion if it enticed more investors to subscribe, which means that the issued stock quantity would be divided among more investors. Importantly, since the allocation was proportional to the order quantity rather than a decreasing function of it (as in the UK, Singapore, Finland), investors had no motive to split their orders into smaller pieces. Therefore, the number of subscribers equals the number of different investors, and the number of accepted orders represents ownership dispersion.

Specifically, we test whether underpricing enticed *more investors* to subscribe to IPOs, which would increase the investor base and the dispersion of ownership. We do that by testing whether ER_j, the IPO excess return that measures underpricing, had a positive effect on $ORDERS_j$, the number of orders accepted at the IPO, which measures the increase in the investor base after the IPO. In fixed-price offers, $ORDERS_j$ is the number of all orders submitted and in auctioned IPOs, $ORDERS_j$ equals the number of orders that offered a price higher than or equal to the auction price. In either case, the issued units were divided among all accepted subscriptions proportionally to the order size. Data on $ORDERS_j$ was available for 273 cases (96.1% of the sample).

We test the relationship between $LORDERS_j = log(ORDERS_j)$ and ER_j in the following model, controlling for other characteristics of the IPOs:

$$(10) \quad \underset{(t\text{ statistic})}{LORDERS_j} = \underset{(1.34)}{-3.650} + \underset{(6.26)}{1.595 \cdot ER_j} + \underset{(3.84)}{0.623 \cdot PROCEEDS_j} + \underset{(4.29)}{6.661 \cdot RM1\text{-}16_j} + \underset{(2.00)}{10.818 \cdot SDER_j} \qquad R^2 = 0.348$$

The hypothesis on the positive effect of underpricing on the investor base is strongly supported, as seen from the positive and highly significant coefficient of ER_j. That is, underpricing attracts *more* investors. This relationship is, however, also consistent with Rock's (1986) theory: if informed investors are more likely to participate

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[18] See also Bolton and von Thadden (1998). Brennan and Franks (1997) found that greater underpricing is associated with allocation which is more discriminating against larger subscribers, thus promoting greater

in underpriced IPOs than in overpriced ones, there would be a positive relationship between underpricing and the number of accepted orders.

Larger IPOs attracted a larger number of subscribers, and each subscription was of a larger size (in monetary value). This follows from the coefficient of $PROCEEDS_j$ being significantly smaller than one, meaning that the number of orders grew less than proportionately with the issue size. Investors were willing to submit larger orders in larger IPOs probably because such IPOs have more liquid aftermarket, which mitigates the liquidity cost of selling their holdings later.

The results also show that more investors participated in IPOs following a rise in market prices. This suggests that favorable market conditions draw small investors to participate in IPOs. Finally, IPOs with greater uncertainty drew more investors.

In conclusion, the results are consistent with the hypothesis that underpricing in IPOs leads to larger ownership dispersion. IPOs that are more underpriced end up with more shareholders.

6. Conclusion

This paper examines three major theories of underpricing in IPOs, using unique data from Israel on the rate of allocation to IPO subscribers, where each subscriber received an equal proportion of her or his order. Such data are unavailable in the U.S.

We first test Rock's (1986) theory of adverse selection by which informed investors choose to participate in underpriced IPOs and uninformed investors receive larger share of the overpriced IPOs. In equilibrium, uninformed investors should earn zero excess return. Our evidence is consistent with the existence of adverse selection:

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ownership dispersion by smaller shareholders.

underpricing was negatively related to the rate of allocation to subscribers. However, the mean excess return earned by uninformed investors was slightly negative, −1.18% or −1.77% when measured over 6 days or 15 days after the IPO, respectively. This is inconsistent with Rock's (1986) prediction and suggests that IPOs were *overpriced* from the viewpoint of uninformed investors. We show, however, that *partially* uninformed investors – those who used only publicly available information about the market that could be obtained costlessly – could improve their performance by subscribing only to IPOs that were preceded by favorable market conditions, measured by high return or low volatility. For these partially informed investors, Rock's (1986) prediction of zero excess return is supported. Apparently there were investors who subscribed indiscriminantly to all IPOs (or subscribe randomly to some) and as a result lost on average. But since it is impossible to short sell securities in IPOs, rational investors could not exploit the fact that there were buyers for securities in IPOs that are likely to decline in price afterwards.

Second, we examine Welch's (1992) theory of information cascades by which investors set their own demand after having observed the demand of others, which leads to herding -- demand is either very high or is very low. Then, underpricing is a means to create a cascade of high demand. The distribution of allocations to IPO subscribers exhibits an extreme U-shaped pattern, indicating herding among investors: they either subscribe overwhelmingly to new issues or largely abstain and then there is undersubscription. We show that if investors who were uninformed about the firm's value had information about the extent of demand, they could improve their performance by avoiding undersubscribed IPOs and joining those with high demand.

Third, we test the proposition that underpricing is a means to increase ownership dispersion for reasons of liquidity (Booth and Chua (1996)) or less monitoring of management (Brennan and Franks (1997)). We find that the number of orders accepted at IPOs – and consequently the number of new shareholders – is increasing in the IPO return, which measures underpricing. While naturally lower issue prices attract greater demand, we observe that this is reflected not only in larger order quantities but also in a greater number of investors.

We find that IPOs are timed to take place after an unusual rise in market prices, and that the offer prices are not fully adjusted to this information. As a result, underpricing and excess demand are related to the pre-IPO market return. This is consistent with Loughran and Ritter's (2001) proposition that issuers do not mind "leaving money on the table" when they raise more money than they have expected.

Our results that excess demand is affected by factors that are known before the IPO, such as issue characteristics and market conditions, may cast doubt on Rock's (1986) reasoning for underpricing. If underpricing was done to attract some level of excess demand, the issue could be priced right, that is, with no underpricing, and then the offer price could be lowered by some constant. Then, excess demand would not be related to any factor. However, we do find that the factors that affect underpricing also affect excess demand. This raises question on the motivation for underpricing by issuers and underwriters.

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Table 1: Characteristics of the IPOs in this study

The last line gives the proportion of the number of IPOs at that category out of the total number of IPOs. The proportion in the last column is out of the 245 IPOs sold by the auction method.

Period: 11/1989-11/1993. Number of IPOs: 284.

Year of issue	Total num.	Composition of unit issued				Method of IPO pricing		
		Stock only	Stock + warrant	Stock + warrant + bonds	Stock + bonds	Fixed price	Auction	
							Total	Closed at max*
11/1989 -1990	10	0	5	4	1	1	9	6
1991	16	3	11	1	1	2	14	10
1992	87	13	57	13	4	11	76	57
1993	171	28	104	34	5	25	146	116
Total	**284**	**44**	**177**	**52**	**11**	**39**	**245**	**189**
Proportion	1.00	0.155	0.623	0.183	0.039	0.137	0.863	0.771^{+}

* "Closed at max" means that the demand at the auction's maximum price exceeded the issued quantity and rationing was necessary. (In auctions, underwriters specified maximum and minimum prices.)

Table 2: Excess returns in IPOs, with adjustment for allocation

The excess return is $ER_j = P_{j,6} / P_{j,0} - M_{j,6} / M_{j,0}$. $P_{j,t}$ is the price on the IPO unit of firm *j* on day *t*, where day 0 is the IPO day and $M_{j,t}$ is the TASE *Karam* market index on day *t* pertaining to the IPO of firm *j*. day 0 is the IPO day.
$ER15_j = P_{j,15} / P_{j,0} - M_{j,15} / M_{j,0}$ is the 15 day excess return on the IPO unit.
$ER150_j = P_{j,150} / P_{j,0} - M_{j,150} / M_{j,0}$ is the 150 day excess return on the IPO unit.
The allocation-weighted excess return is $ERAW_j = ALLOC_j \times ER_j - interest_j$, where $ALLOC_j$ is the allocation to subscribers in the IPO of firm *j*, calculated as the ratio of issued units to the total demand, $0 < ALLOC \leq 1$, and $interest_j$ is the one-day interest cost. $ERAW150_j$ is the allocation-weighted excess return over 150 days after the IPO.

Period: 11/1989-11/1993. Number of IPOs: 284.

	Variable	Mean	Median	Skewness	Minimum	Maximum
1	*ER*	0.1199 (7.20)	0.0660	1.264	-0.6581	1.7671
2	*ER15*	0.1314 (6.77)	0.0563	1.603	-0.6775	2.1920
3	*ER150*	0.1500 (4.16)	0.0563	1.728	-0.9450	3.7424
4	*ERAW*	-0.0118 (1.77)	0.0001	-0.736	-0.6587	0.5731
5	*ERAW15*	-0.0177 (2.41)	0.0001	-0.440	-0.6781	0.5057
6	*ERAW150*	-0.0243 (1.52)	-0.0002	0.706	-0.9457	1.1848

(*t* statistics, testing that the mean is different from zero.)

Table 3: Allocation in IPOs

$ALLOC_j$ is the allocation to subscribers in the IPO of firm j, calculated as the ratio of issued units to the total demand, $0 < ALLOC \leq 1$.

The excess return is $ER_j = P_{j,6} /P_{j,0} - M_{j,6} /M_{j,0}$. $P_{j,t}$ is the price on the IPO unit of firm j on day t, where day 0 is the IPO day and $M_{j,t}$ is the TASE *Karam* market index on day t pertaining to the IPO of firm j. day 0 is the IPO day.

Period: 11/1989-11/1993. Number of IPOs: 284.

	Mean	Median	Minimum	Maximum	Obs.
ALLOC	0.3595	0.0478	0.0003	1.0000	284
For $ER_j < 0$: $ALLOC_j$	0.6134	0.9200	0.0015	1.000	95
For $ER_j > 0$: $ALLOC_j$	0.2319	0.0127	0.0003	1.000	189

Table 4: The determinants of IPO allocations and excess returns

$$ER_j = a_0 + a_1\,RM1\text{-}6_j + a_2\,RM6\text{-}16_j + a_3\,PROCEEDS_j + a_4\,AUCTION_j + a_5\,SDER_j + a_6\,UNIT_j + n_j$$

$$ALLOCT_j = b_0 + b_1\,RM1\text{-}6_j + b_2\,RM6\text{-}16_j + b_3\,PROCEEDS_j + b_4\,AUCTION_j + b_5 SDER_j + u_j\,.$$

ER_j = the excess return on the IPO unit of firm *j* over days (0, +6).
$ALLOCT_j = log((ALLOC_j + a)/(1+ALLOC_j+a))$ is the transformed $ALLOC_j$, the proportional allocation rate to subscribers, $1 < ALLOC_j \leq 1$, and a= ½/284.
$RM1\text{-}6_j$ = market return from day -6 to day -1.
$RM6\text{-}16_j$ = market return from day -16 to day -6.
$PROCEEDS_j$ = logarithm of size of issue (in December 1992 prices).
$SDER_j$ = standard deviation of daily excess returns, days (+6,+15).
$AUCTION_j$ = 1 for IPOs sold at the auction method (with an upper and lower bounds) and = 0 for IPOs sold at a fixed price.
$UNIT_j$ = 1 in IPOs of units that include other securities in addition to stock, = 0 in IPOs of stock alone.

Period: 11/1989-11/1993. Number of IPOs: 284.

	Dependent variable	
	ER_j	$ALLOCT_j$
Constant	-0.563 (1.89)	15.343 (2.02)
$RM1\text{-}6_j$	1.388 (2.82)	-26.502 (3.04)
$RM6\text{-}16_j$	2.343 (5.53)	-33.251 (4.40)
$PROCEEDS_j$	0.043 (2.39)	-0.893 (2.00)
$SDER_j$	4.500 (3.31)	-68.215 (3.90)
$AUCTION_j$	-0.128 (2.20)	1.348 (2.02)
$UNIT_j$	-0.120 (2.27)	
R^2	0.213	0.150

(*t* statistic in parentheses; standard errors use White’s (1980) robust estimation.)

Table 5: Market return around the IPO day

Daily average return on the market *Karam* index before and after day 0, the IPO day.

	Days -26 to -16	Days -16 to –6	Days -6 to -1	Days 0 to +10
Market return (%)	0.326	0.225	0.144	0.138
Ratio relative to return in (0, +10)	2.36	1.56	1.04	1.00

Figure 1: The distribution of excess return in IPOs

The excess return is $ER_j = P_{j,6}/P_{j,0} - M_{j,6}/M_{j,0}$. $P_{j,t}$ is the price on the IPO unit of firm *j* on day *t*, where day 0 is the IPO day and $M_{j,t}$ is the TASE *Karam* market index on day *t* pertaining to the IPO of firm *j*.

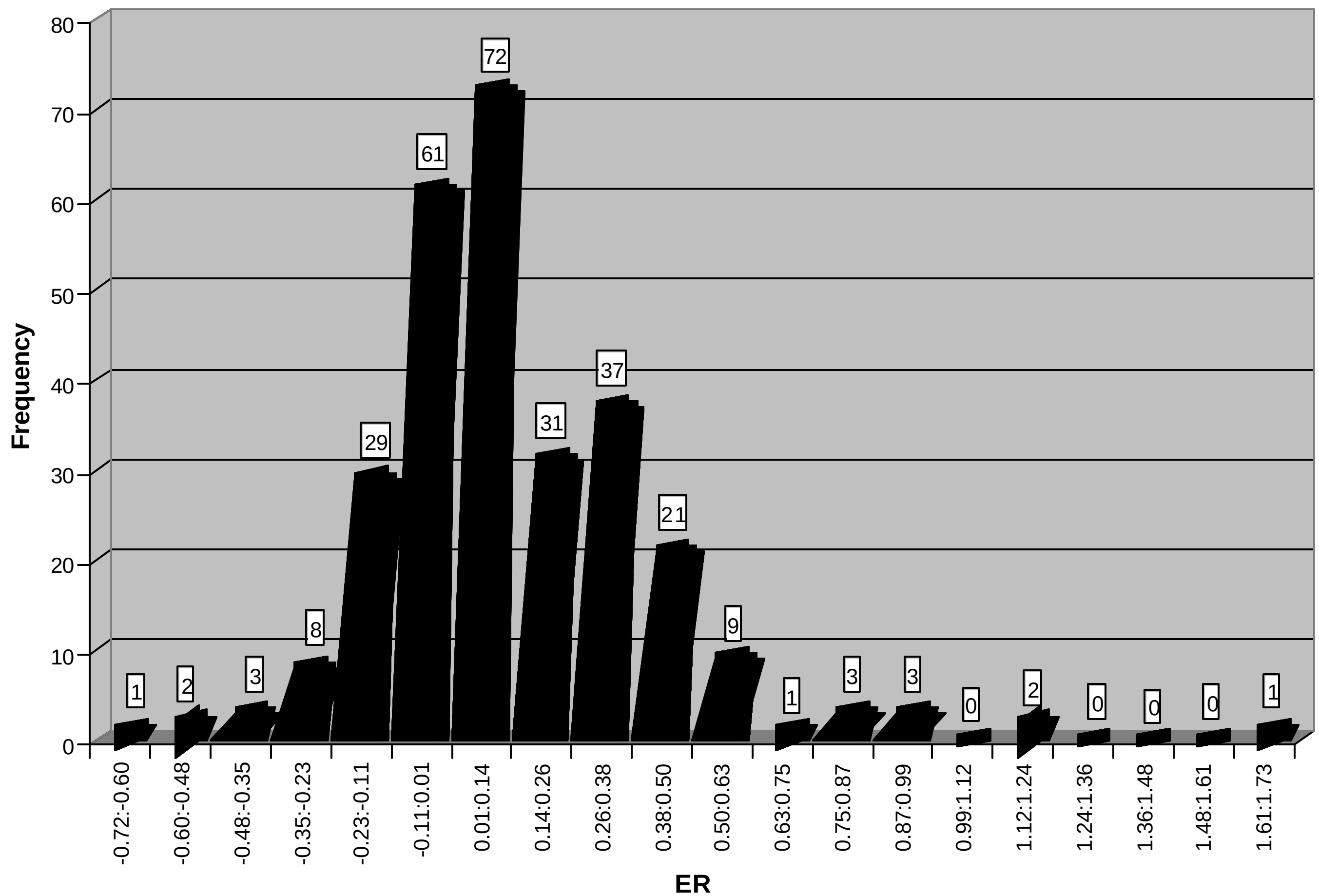

Figure 2: The distribution of allocations to investors in IPOs

$ALLOC_j$ is the allocation of units of firm j to subscribers, calculated as the ratio of issued units to the total demand for units at the IPO.

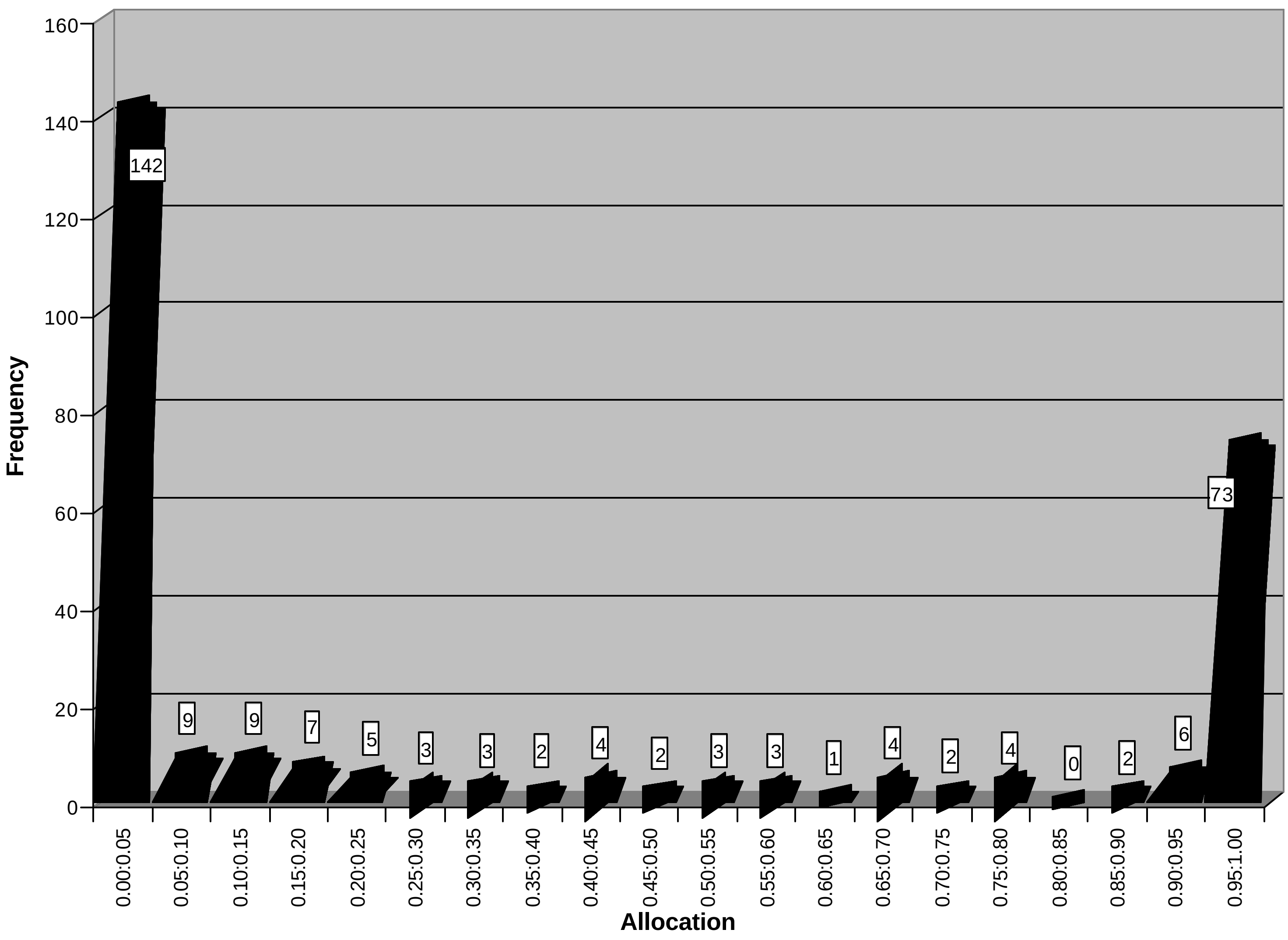

Figure 3: The distribution of allocation-weighted excess return in IPOs

The allocation-weighted excess return is $ERAW_j = ALLOC_j \times ER_j - interest_j$, where $ER_j = R_j - RM_j$, the excess return on the IPO unit over days (0, +6), $ALLOC_j$ is the proportional allocation to shareholders who participated in the IPO of firm *j* and $interest_j$ is he one-day interest cost.

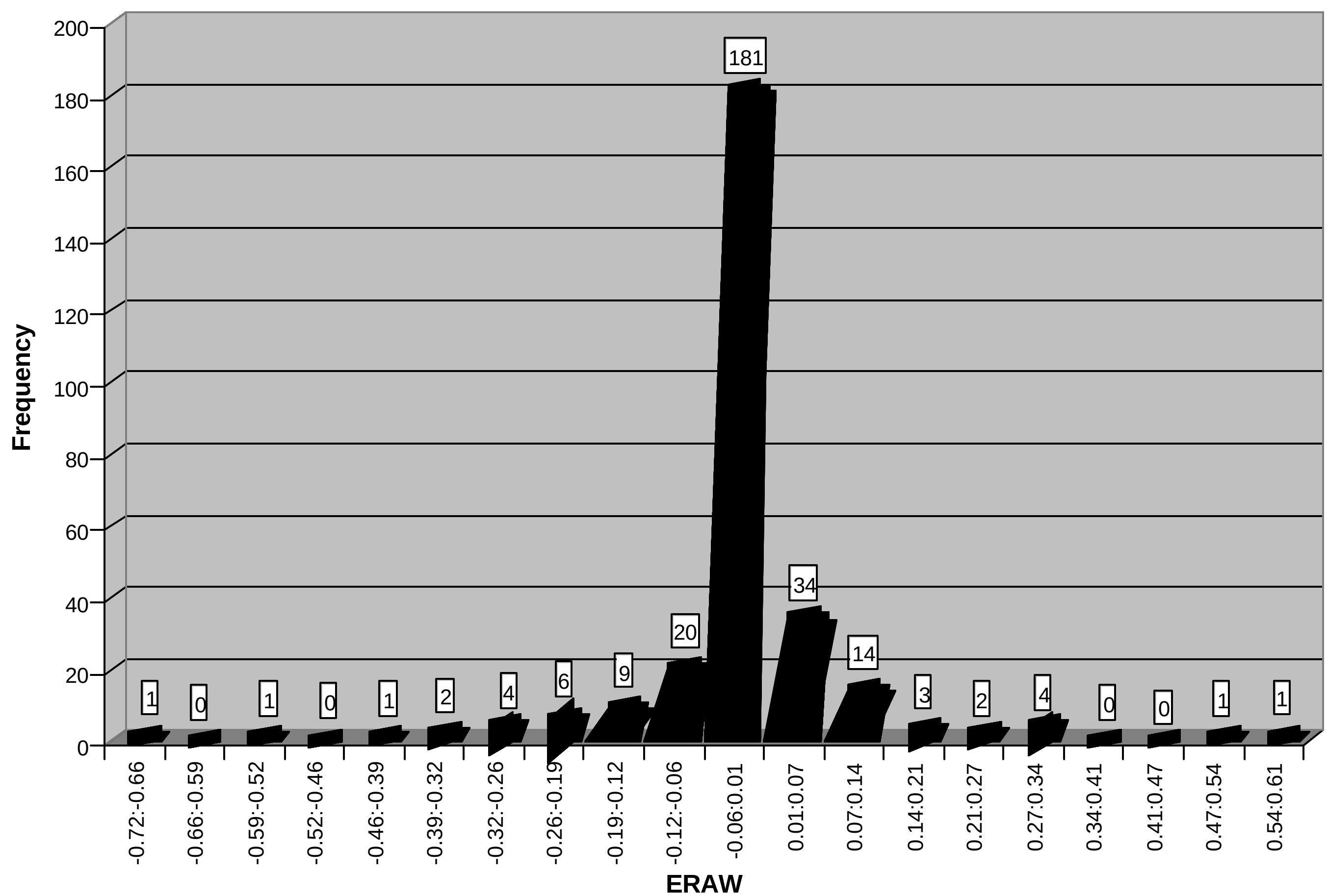

Figure 4: The allocation-weighted excess return against Allocation

The allocation-weighted excess return is $ERAW_j = ALLOC_j \times ER_j - interest_j$, where $ER_j = R_j - RM_j$, the excess return on the IPO unit over days (0, +6), $ALLOC_j$ is the proportional allocation to shareholders who participated in the IPO of firm j and $interest_j$ is he one-day interest cost. $ALLOCT_j = (ALLOC_j + a)/(1 - ALLOC_j + a)$, where a= ½/284. The data presented here is for half the sample (142 IPOs) for which $ALLOC_j$ below its median.