Allocations, Adverse Selection and Cascades in IPOs
Evidence from Israel

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Abstract

This paper examines three theories of IPO underpricing, using data from Israel where the allocations to subscribers are equally prorated and publicly known. Rock's (1986) theory of adverse selection is supported: subscribers receive greater allocations in overpriced IPOs. And, while the average IPO excess return is 12%, the simulated *allocation-weighted* return to uninformed investors is slightly *negative.* Welch's (1992) theory of information cascades is supported by the pattern of allocations: demand is either extremely high or there is undersubscription, with very few cases in between. Finally, the theory that underpricing is a means to increase ownership dispersion is tested using data on accepted subscriptions and obtains a strong support.

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 theories of underpricing in IPOs by using data from the Tel Aviv Stock Exchange (TASE) which make these tests feasible. In addition, a number of other explanations of underpricing, which are not feasible in Israel, are excluded.

The high positive returns observed in IPOs cannot be earned in practice because of adverse selection. Rock (1986) proposed that 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).

Rock's (1986) theory cannot be directly tested in the U.S. where the allocation of shares to subscribers in IPOs is at the discretion of brokers and varies across subscribers.[2] It is therefore impossible to simulate the return that would be earned by uninformed investors, nor is it possible to examine whether allocations are related to underpricing.

In Israel, however, the allocation of securities in IPOs is done by *equal proration* to all subscribers and the allocation rate was publicly announced. This enables us to directly test Rock's (1986) theory, which we do in two ways.

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

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

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(ii) We simulate the excess return earned by investors who would act as uninformed ones -- participate equally in each and every IPO (or subscribe randomly to some IPOs).

We obtain that there is adverse selection in IPOs, consistent with Rock (1986). In addition, while the average IPO excess return is about 12%, the simulated excess return to uninformed investors is slightly *negative* albeit with marginal statistical significance. This may mean that IPOs may have been slightly *overpriced*. However, investors whom we call *partially informed* could slightly improve their performance and earn zero return, as proposed by Rock (1986). These investors were uninformed about the issuing firm, but they could use publicly available information about the market and participate selectively in IPOs that were preceded by high market return or low volatility.

The second theory that we examine is that of Welch's (1992) on information cascades or herding. 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 finds that indeed investors either subscribed overwhelmingly to new issues or largely abstained, with very few cases in between, which is consistent with information cascades.

Thirdly, we examine the theory that underpricing is a means to increase ownership dispersion after the IPO. Booth and Chua (1996) proposed that the benefit of greater ownership dispersion is that it increases stock liquidity which in turn reduces the firm's cost of capital. Brennan and Franks (1997) proposed that greater ownership dispersion serves the interest of managers who do not want to be monitored by large

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[2] Michaely and Shaw (1994) find results that are consistent with Rock's (1986) theory by relating IPO underpricing to the extent of subscription by informed investors which are considered informed.

shareholders, in which case underpricing may be viewed as agency cost. We find strong support for this theory: greater underpricing is associated with a larger number of accepted subscription in the IPO, controlling for the firm's size.

We find that underpricing is done deliberately: it is a function of some factors that are known before the IPO price is set. These factors also affect the excess demand in the IPO. The evidence on deliberate underpricing casts doubt on the view that the initial IPO returns, which measure underpricing, are a result of fads and irrational demand, as has often been suggested. Our evidence shows that underpricing is greater when the IPO is preceded by a rise in market prices, meaning that issuers are not fully raising the issue price when market conditions are favorable. This evidence is consistent with the Loughran and Ritter's (2001) proposition that issuers do not mind "leaving money on the table" when they raise in the IPO more than they have expected.

Our setting enables us to exclude some theories on underpricing which are not accommodated by the institutional framework in Israel. Ruud (1993) suggested that IPOs generate an average positive excess returns because underwriters are engaged in price stabilization, which is allowed by law. The price stabilization reduces the incidence of negative IPO returns and thus the average IPO return is positive. However, in Israel the law does not allow price stabilization after the IPO. This makes Ruud's (1993) explanation of underpricing inapplicable in our setting.

Another theory, by Tinic (1988), suggests that underpricing serves as a form of insurance for underwriters against legal liability and the associated damages. In Israel, however, there were no cases of law suits against underwriters.

Rock's (1986) theory was studied in other countries where data was available on allocation to subscribers. The results of these studies 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 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, up to about -5%, 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 Israel allocation was simply proportional to the order size [3] and every investor wishing to participate in the IPO could do so at any time during the IPO day. This enables to simulate the returns earned by uninformed investors and test Rock's (1986) propositions on the return-allocation relationship.

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, and Section 6 presents evidence on the participation of institutional investors in IPOs. Section 7 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 presents some information about the IPOs in our study. Most IPOs − 84.6% of them − 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

Two pricing methods were used in the IPOs: fixed price or auction with specified minimum and maximum prices. Auction was by far the most common method, used in about 86% of the IPOs. In auctions, investors submitted bids for some quantity, specifying a price within the announced range (including the upper and lower bounds). However, most auctioned IPOs were effectively like fixed-price IPOs with the price set at the maximum auction price: 77% of auctioned IPOs closed at the maximum price, which ended up being the IPO price, and the allocation was done by proration. When equilibrium was attained at a price below the maximum, bidders at the maximum price were allocated the full quantity they ordered and paid the equilibrium auction price.

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[3] Except in four cases during the period 11/1989-11/1993, 1.4% of the sample.
[4] In 12/1993, it was mandated that *all* IPOs be auctioned with no maximum prices; see Kandel, Sarig and Wohl (1999), Hauser et al (2000).

The unit price was included in the prospectus which was published one week (five business days) before the IPO day. In a case of an auction, maximum and minimum prices were announced. Subscriptions were received by brokers on the IPO day, from morning till noon. To guarantee the integrity of the orders, investors had to deposit with their broker the full amount of their subscription on the day of the IPO.

Our simulation of an uninformed investor assumes bidding at the fixed price or at the maximum auction price, which would guarantee this investor to be apportioned some units in each and every IPO. Bidding below the maximum price would have excluded this 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 method that was used for small-cap securities, called *Karam*, and thus their 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 return on IPOs six days after the IPO (which are two or three days after the warrants and bonds in the unit started to trade). Underpricing is measured by the initial six-day excess return on the IPO unit of securities of firm j,

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

$P_{j,t}$ is the unit price of firm j on day t, day 0 being the IPO day, and $P0_j$ is the unit's issue price. The post-IPO unit price is the sum of the market prices of its components (of the

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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 small float, similar to the newly issued

securities. To examine longer-term returns, we also calculate the return over 150 days[6]

after the IPO:

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

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INSERT TABLE 2

INSERT FIGURE 1

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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 11.99%, highly

significant ($t = 7.20$). Two third of the returns (66.6%) are positive; this proportion is

significantly different from a chance result of 50% ($t = 5.58$). The average 150-day

excess return, $ER150_j$, is slightly higher, 15.00% ($t = 4.16$). Notably, the mean excess

return from day +6 to day +150 is insignificantly different from zero (mean = 2.95%,

$t=1.10$), and the initial excess return ER_j shows no 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 seems to price the issued units efficiently immediately

after the IPO, and that the IPO excess return is not a result of fad or overreaction.

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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 was limited because of the later expiration of warrants and convertible
bonds, which were included in most of the IPOs, and because of limitations on the availability of data..

2.2. Allocation

Testing Rock's (1986) theory requires having data on the rate of allocation to subscribers in IPOs. In Israel, the allocation rate of the issued units was equal among all subscribers and was publicly disclosed at the end of the IPO day. The allocation rate was simply the ratio of the number of units issued to the number of units ordered by investors, and equaled 1.0 when the issue was undersubscribed,[7] in which case the underwriter absorbed the unsold quantity. $ALLOC_j$ denotes the allocation rate in IPO j, $0 < ALLOC_j \leq 1$.

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 IPO 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 IPO price and whether other investors subscribe or abstain. Based on that, the investor then decides on whether to subscribe to the IPO. As one investor's decision is influenced by that of others, there is herding into subscribing or abstaining. As a result there should be either overwhelming

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oversubscription or undersubscription. Figure 2 indeed shows evidence of very high demand or abstention, with a 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 IPO price compared to what investors considered the right price. An error in either direction of the correct price 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

IPOs seem to have been deliberately underpriced. This is evident from the fact that both underpricing and allocation are affected by publicly available information known prior to the IPO. 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 IPO price to market conditions, the market return before the IPO price is set should be unrelated to underpricing. The pricing decision of the IPO was made when the prospectus was submitted, five or six days before the issue day. Issuers could withdraw the prospectus and cancel the IPO, but it was very rarely done. We consider the ten-day market return before the IPO price was set, days –16 to –6,

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

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[7] The allocations in 4 IPOs (1.4% of sample) was a decreasing function of the quantity ordered by investors. For these cases we use for $ALLOC_j$ the ratio of issued units to the quantity subscribed. Excluding these four observations from the sample does not change the results in any meaningful way.

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

We expect that $RM1\text{-}6_j$ should affect ER_j since this market return occurred after the IPO price had been set. However, $RM6\text{-}16_j$ is not expected to affect ER_j if this information about the market were fully incorporated in the pricing of the IPO

(ii) $LSIZE_j$ is the logarithm of the issue size, in monetary units (Israeli Shekels, in constant prices of December 1992). If we liken the IPO to a block sale, then it is expected that larger IPOs are underpriced more in order to entice sufficient demand.[8]

(iii) $AUCTION_j = 1$ 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.[9] As a result, inderpricing is expected to be smaller in IPOs by auction. While evidence shows that IPO underpricing was smaller in countries where auctions are used (Loughran, Ritter and Rydkvist (1994)), this is the first study that compares the effects on underpricing of the two methods of IPOs within the *same* market.

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[8] Kraus and Stoll (1972) showed that large block sales are associated with a temporary liquidity discount.
[9] We found no systematic factors affecting the selection of the method of issue by firms and underwriters. In a Probit model of the determinants of the choice of the auction method, observable variables such as $LSIZE_j$, $SDER_j$ and $RM6\text{-}16_j$ did not have any significant effect.

(iv) $SDER_j$ measures the uncertainty about the IPO price. It is the standard deviation

of daily excess return over ten days (+6 to +15) after the IPO. Theory predicts a positive

relationship between underpricing and 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."   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. In addition, risk-averse underwriters with firm commitment to

absorb the quantity that is unsold at the IPO price may underprice the issue to reduce

their risk. Indeed, empirical evidence shows that underpricing rises with price

uncertainty (Ritter (1984)).

(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 rather than stock alone is usually affected by corporate finance and incentive

issues, 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.

      The effects of these variables are examined in regression models where the IPO

excess return, ER_j, and the allocation rate are functions of the pre-IPO returns $RM1\text{-}6_j$ and

$RM6\text{-}16_j$, the issue size $LSIZE_j$, the method of sale $AUCTION_j$, the uncertainty $SDER_j$ and

the composition of the 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 $a= \frac{1}{2}/284$, to accommodate the cases where $ALLOC=1$ or is practically zero.[10] 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 means 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 (it is

therefore not included in the final estimation of the allocation model).

The coefficients of $RM1\text{-}6_j$ are significant in both models, as expected. Given that

the IPO price was stale by the time the IPO took place, a rise in the market price would

make the issue underpriced, and this would also create excess demand and smaller

allocation. However, the significant coefficients of $RM6\text{-}16_j$ imply that underwriters

deliberately did not sufficiently adjust IPO prices after having observed changes in

market prices. The mean of $RM6\text{-}16_j$ is 2.27% ($t = 10.82$) and the median is 3.08%,

which is an unusually high ten-day return. This means that IPOs were more likely to take

place after there has been a rise in market prices. The coefficient of $RM6\text{-}16_j$ being 2.343

(see Table 4) means that the average effect of prior market return on underpricing was

5.32%, which is a sizable part of the entire underpricing. This shows that a great deal of

deliberate underpricing was associated with a pre-IPO rise in market prices.

This evidence is consistent with Loughran and Ritter's (2001) explanation of

underpricing that results from incomplete adjustment of the IPO price to pre-IPO

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information about demand, which is revealed in the book-building process. The evidence is that underpricing is greater when underwriters raise the IPO price relative to the pre-announced IPO price range, implying that they do not fully adjust the price to information. Hanley (1993) suggested that underwriters want to elicit truthful information from investors during the book building process, hence they do not fully adjust the IPO price to information that is revealed then. Based on prospect theory, Loughran and Ritter (2001) proposed that issuers do not mind "leaving money on the table" if the IPO brings them higher value than they have expected. In Israel, the pre-IPO process was not similar to that in the U.S. and therefore Hanley's (1993) explanation may not apply. But doing an IPO following a rise in market prices enables issuers to raise their issue price and raise more money. If issuers just wanted to underprice IPOs irrespective of market conditions, they would fully adjust the IPO price to the rise in market prices and then reduce it by a constant; but then there would be no relationship between underpricing and the pre-IPO market return. The existence of such a relationship is consistent with Loughran and Ritter's (2001) proposition.

Larger IPOs were more underpriced, perhaps to enable traders absorb the larger quantity of securities. However, the underpricing of IPOs was greater than was necessary to attract a sufficient level of demand: excess demand of these IPOs was higher.

The use of auction led to smaller underpricing, which explains the popularity of this method (see Table 1). Indeed, the auction method (without setting an upper price limit) was mandated by the Israeli Securities Authority in December 1993. As expected, this reduced underpricing (Kandel et al (1999), Hauser et al (2000)). The smaller underpricing also reduced the excess demand in auction IPOs.

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

Greater uncertainty about the issued securities led to greater underpricing as well as greater excess demand, which resulted in smaller allocation. That is, the greater underpricing of riskier IPOs did not necessarily provide greater risk premiums to their buyers. The result here is consistent with the suggestion that riskier IPOs are priced lower to protect the interests of risk-averse underwriters.

Finally, underpricing was smaller for IPOs of units that included, in addition to stock, warrants or bonds or both. [11] This is consistent with the underwriters' claim that unit IPOs are "easier" to sell.

Underpricing measured by ER_j does not necessarily imply gains to uninformed investors since, as suggested by Rock (1986), greater excess returns are offset by smaller allocations. This is examined in the next section.

3.   Two tests of Rock's theory

3.1.   Test I of Rock's theory: adverse selection

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

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

$$(6) \quad ER_j = \quad\quad 0.093 \quad - 0.028\ ALLOCT_j$$
$$(t\ \text{statistic})^{12} \quad (6.62) \quad (9.07) \quad\quad\quad\quad R^2 = 0.225$$

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Lest the results are unduly affected by the extreme cases where $ALLOC_j > 0.95$, we

exclude these observations (they constituted 25.7% of all IPOs). Estimating the model

for 211 IPOs where $ALLOC_j < 0.95$, we obtain:

(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.[13]

      Another examination of the adverse selection proposition is presented in Table 3,

where the sample divided between overvalued and undervalued IPOs. In *overvalued* IPOs

(where $ER_j < 0$) the average allocation rate is 0.613 whereas it is 0.232, less than half, in

undervalued IPOs (where $ER_j > 0$). The difference in the allocation rates is much greater

when considering the medians. In overvalued IPOs, the median allocation is 0.920

whereas for undervalued IPOs, the median allocation is very small, 0.013. This strongly

supports the proposition of adverse selection in IPOs.

      The negative return-allocation relationship can also be obtained under a simpler

scenario. Assume that all investors are equally informed in the sense that each observes

the true value of the issued company with some error, and underwriters err in setting the

IPO price equal to this value. If the support of the distribution of investors' beliefs is

narrow, it is likely that the underwriter will set the price outside of this support. Then,

when the IPO price is smaller than the true value there is excess demand and low

allocation, or if the opposite occurs there is undersubscription and full allocation to those

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[11] Underpricing was not significantly affected by whether the additional securities in the unit were warrants or bonds or both.

[12] The t statistics are calculated using White's (1980) robust standard errors.

[13] Koh and Walter (1989), Levis (1990) and Brennan and Franks (1997) found a positive relationship between oversubscription and underpricing.

who subscribe. When trading commences, the market price adjusts to the true value, and this gives rise to a negative relationship between the IPO return and the allocation rate.

3.2. Test II of Rock's proposition: 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 excess IPO 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[14] 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 did not default on the commitment to buy the number of units ordered at the specified price.

<div align="center">INSERT FIGURE 3</div>

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.[15] The median of $ERAW_j$ is practically zero. The distribution of $ERAW_j$ is negatively skewed, affected by

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[14] 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 0.0054.

[15] 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 $t = 1.75$.

the "lemons" where investors were allocated the full amount of their order and the return was negative. As a further check of the allocation-weighted excess return, we calculate it over 15 days, from day 0 to +15. Its mean is slightly more negative, -1.77% with $t = 2.41$, quite significant. The long-term allocation-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 the IPO is negative with marginal statistical significance.

The negative mean return $ERAW_j$, albeit with marginal statistical significance, means that uninformed investors lose on average, which is inconsistent with Rock's (1986) prediction. This suggests that from the viewpoint of uninformed investors, IPOs are slightly *overpriced*. Perhaps IPOs attract a selective type of investors that are overoptimistic about their prospects, or are risk loving. Because it was impossible to short the IPO stock, the views of informed investors could not play a role in determining the market price right after the IPO.

4.   **Conditioning IPO subscription**

Investors that were uninformed about 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 these uninformed investors could improve their performance by conditioning their subscription on information other than the value of the issuing firm. The following shows examples of these investors' performance.

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) $RM1\text{-}16_j$, 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.

Market uncertainty, measured by $SDRM_j$, had negative effect on investors'

earnings, but this effect was weaker. When both measures of market performance,

RM1-16ⱼ and *SDRMⱼ*, 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 $LSIZE_j$, $AUCTION_j$ 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.

The results thus suggest 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 such information could erase the small loss that they would have incurred if

they subscribed 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 by 63 cases (22% of the sample) of undersubscribed IPOs ($ALLOC_j = 1$); 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 the mean $ERAWj$ is 0.0037 ($t = 1.34$). 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. In Israel, the cascade was bounded by the requirement that investors deposit the entire order amount for one day, which entails an interest cost, $interest_j$ (see (7)). This cost would offset the gain in IPOs with very small allocation (high demand) and thus discourage 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· $ALLOCT_j$
         (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**

Underpricing in IPOs leads to rationing and then, if the allocation scheme is discretionary, the issuer may increase the dispersion of stock ownership by favoring small subscribers. There are two explanations for the issuer's preference for broader ownership base of the firm's stock. Booth and Chua (1996) proposed that larger investor base increases the liquidity of the stock in the secondary market after the IPO, which in turn lowers the firm's cost of capital and increases its value (Amihud and Mendelson (1986), Amihud, Mendelson and Uno (1999)). Then, underpricing is viewed as the price paid by the issuer to achieve greater value for the stock in the market, and is thus beneficial to the firm. On the other hand, Brennan and Franks (1997) proposed that diffused ownership serves the interests of managers who are averse to being monitored by large shareholders.[16] By this hypothesis, underpricing buys private benefits for

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[16] 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 ownership dispersion by smaller shareholders.

managers. Since the cost is borne in the IPO by the firm's owners, it will be undertaken only when the cost to the decision makers is smaller than the benefit to them.

We test the hypothesis that *IPO underpricing is positively associated with ownership dispersion* immediately after the IPO. Unlike in the UK, issuers in Israel have no discretion in allocating shares to subscribers, and therefore underpricing can increase ownership dispersion if it entices more investors to participate in the IPO. Importantly, since the allocation was proportional rather than a decreasing function of the order size (as it was in the UK, Singapore, Finland), investors had no motive to split their orders into smaller pieces. Thus, it can be assumed that each order represents a different investor, and then the number of orders accepted provides a measure of the ownership dispersion.

Denote by $ORDERS_j$ the number of orders accepted at the IPO. In fixed-price IPOs, these are all the orders submitted (or, all subscriptions) because the issued quantity was divided among all subscribers. In auctioned IPOs, the accepted orders are those that offered to buy the units at a price that was higher than or equal to the price at which the auction closed. Data on accepted orders were available for 273 cases (96.1% of the sample). We use the transformation of the order size, $LORDERS_j = log(ORDERS_j)$.

The following model tests how $ORDERS_j$, which serves as a measure of ownership dispersion after the IPO, was affected by underpricing, measured by the excess return ER_j, controlling for other characteristics of the IPOs.

(10) $LORDERS_j = -3.650 \quad + \quad 1.595 \cdot ER_j \quad + \quad 0.623 \cdot LSIZE_j \quad + \quad 6.661 \cdot RM1\text{-}16_j$
       (*t* statistic)   (1.34)   (6.26)   (3.84)   (4.29)

       $+ \quad 10.818 \cdot SDER_j$
       (2.00) $R^2 = 0.348$

The hypothesis is strongly supported. The highly significant coefficient of the IPO excess return ER_j means that greater underpricing is positively associated with the number of accepted orders and thus generates larger investor base and greater dispersion of ownership after the IPO. We already know from (6) that greater underpricing is associated with higher demand relative to the issue size. However, higher demand could be generated by each investor increasing his or her order size. The result here is different: greater underpricing attracted *more* investors.

This relationship is obtained after controlling for the size of the IPO, the market return before the IPO and the IPO uncertainty. (Other variables did not have significant effect.) Larger IPOs led to a larger number of accepted orders, and they were each of larger size (in monetary value). This follows from the coefficient of $LSIZE_j$ 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 probably because larger IPOs have more liquid after market, which mitigates the liquidity cost of selling their holdings later. Finally, The uncertainty about the IPO led to smaller size of each accepted order. This follows from the fact that holding the IPO size constant, higher uncertainty led to more orders being accepted. Indeed, it is expected that risk averse investors would have smaller holdings of riskier securities.

In conclusion, the results strongly support the hypothesis that underpricing in IPOs is associated with greater ownership dispersion.

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6.   **Institutional investors**

Institutional investors may be considered more informed and sophisticated, thus are more likely to participate in IPOs that are underpriced, as suggested by Rock (1986). We test this hypothesis here.

We know of the participation of institutional investors only when it was indicated in the prospectus that they commitment to buy a certain number of units at the IPO price. This price was either the price that was fixed for the IPO, or in the case of an auction it was the equilibrium price that was achieved then. The institutional investors benefited from receiving the entire quantity that they had ordered (up to a limit set by the Securities Authority) regardless of the allocation rate at the IPO. In 48 cases (17% of the sample) the prospectus indicated such participation by the institutional investors.

If institutional investors are informed, they should be more likely to participate in underpriced IPOs where ER_j is greater. Also, they may participate more in oversubscribed IPOs that may have attracted informed investors. We examine this hypothesis in the following probit model, where $INSTDUM_j = 1$ when the participation of institutional investors was indicated in the prospectus (zero otherwise):

(11) $INSTDUM_j = -15.678 - 0.060 \cdot ER_j - 0.014 \cdot ALLOCT_j + 0.879 \cdot LSIZE_j$
        (t statistic)   (7.91)   (0.14)   (0.56)   (7.46)

$$R^2 = 0.264$$

The results show that the participation of institutional investors was unrelated to underpricing or to investors' interest. The coefficients of both ER_j and $ALLOCT_j$ are insignificantly different from zero. If institutional investors are assumed to be better informed than other investors, these results are inconsistent with Rock's (1986)

explanation of the cause for underpricing. But it is quite likely that institutional investors were not better informed. Indeed, there is also no significant relationship between the allocation-weighted excess return $ERAW_j$ and $INSTDUM_j$. Alternatively, if they were better informed, they may not have wished to disclose their participation in the prospectus because this would have enticed greater demand and, in the case of an auction IPO, would raise the price that they would have to pay.

Being large investors, Institutional investors chose to participate in larger IPOs because these IPOs have better after-market liquidity which accommodates large investors who may need to sell their holdings after the IPO. Or, underwriters who were concerned about their ability to sell large IPOs solicited the participation of institutional investors.

7.   **Conclusion**

This paper examines three theories of underpricing in IPOs. First, we test Rock's (1986) theory of adverse selection by which uninformed investors receive large allocations of securities in overpriced IPOs and small allocations in underpriced IPOs. In equilibrium, they earn zero excess return. 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. 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 (Bolton and von Thadden (1998)). The study employs Israeli data on the allocation rate to IPO subscribers

and on the number of orders accepted. In particular, the allocation to IPO subscribers is done by equal proration. This enables to simulate the return earned by uninformed investors.

We find evidence of adverse selection: there is a negative relationship between underpricing and the rate of allocation to subscribers. And, the mean excess return to uninformed investors is slightly negative, -1.18%, although its statistical significance is marginal.   This seems inconsistent with Rock's (1986) prediction. However, we show that investors who were uninformed about the issuing firm's value could improve their performance and break even by subscribing to IPOs that were preceded by good market performance, measured by high return or low volatility. This means that there may be *partially* informed investors – those that are uninformed about the firm but informed about the market – for whom the results are consistent with Rock's (1986) prediction.

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. This pattern is consistent with Welch's (1992) model of information cascades in IPOs.   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.

The hypothesis that underpricing is a means to increase ownership dispersion (Booth and Chua (1996), Brennan and Franks (1997)) is strongly supported by the data. We find that the number of orders accepted at the IPO -- and consequently the number of new shareholders -- is increasing in the IPO return, which measures underpricing.

Our estimations show evidence of deliberate underpricing: both the initial IPO return and the allocation (which measures excess demand) were affected by factors known before the IPO price has been set. These factors include the pre-IPO market return, size of IPO, the use of auction method, the type of unit of securities that was issued, and the uncertainty about the IPO. These results are somewhat puzzling. If underpricing was done to elicit demand by any of the theories examined, it did not have to be related to these factors. Instead, underwriters could price the issue properly, and then reduce the price by an amount that is unrelated to these factors. Our results lend support to Loughran and Ritter's (2001) explanation of underpricing that results from incomplete adjustment of IPO prices to information available to issuers. They proposed that issuers do not mind "leaving money on the table" when they raise more money than they have expected. We obtain that IPOs are more likely to take place after favorable market conditions, indicated by a relatively high rise in market prices, and since the IPO price is not fully adjusted to this information, underpricing when it is preceded by a rise in market prices.

Finally, we examine the participation of institutional investors by way of precommitting to buy a certain quantity at the IPO price. These investors may be considered informed and thus are expected to participate more in underpriced IPOs. However, we find that their participation is unrelated to underpricing or to the extent of demand -- their preference was to participate in large IPOs. While this evidence is not consistent with Rock's (1986) theory on underpricing, it may simply suggest that institutional investors were not better informed than other investors.

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Table 1: Characteristics of the IPOs in this study

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**
Propor-tion	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.)

+ The proportion out of the 245 IPOs sold by the auction method.

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.

$ER150_j = P_{j,150}/P_{j,0} - M_{j,150}/M_{j,0}$ 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, $0 < ALLOC \le 1$, 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	*ER150*	0.1500 (4.16)	0.0563	1.728	-0.9450	3.7424
3	*ERAW*	-0.0118 (1.77)	0.0001	-0.736	-0.6587	0.5731
4	*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 allocation and excess return

$$ER_j = a_0 + a_1 RM1\text{-}6_j + a_2 RM6\text{-}16_j + a_3 LSIZE_j + a_4 AUCTION_j$$
$$+ a_5 SDER_j + a_5 UNIT_j + n_j$$
$$ALLOCT_j = b_0 + b_1 RM15_j + b_2 RM521_j + b_3 LSIZE_j + b_4 AUCTION_j$$
$$+ b_5 SDER_j + u_j .$$

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, $1 < ALLOC_j \leq 1$, where $a = \frac{1}{2}/284$.
$RM1\text{-}6_j$ = market return from day -6 to day -1.
$RM6\text{-}16_j$ = market return from day -16 to day -6.
$LSIZE_j$ = logarithm of size of issue (in December 1992 prices).
$AUCTION_j$ =1 for IPOs sold at the auction method (with an upper and lower bounds) and
0 for IPOs sold at a fixed price.
$SDER_j$ = standard deviation of daily excess returns, days (+6,+15).
$UNIT_j$ = 1 in IPO of units that include other securities in addition to stock.

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

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

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

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.
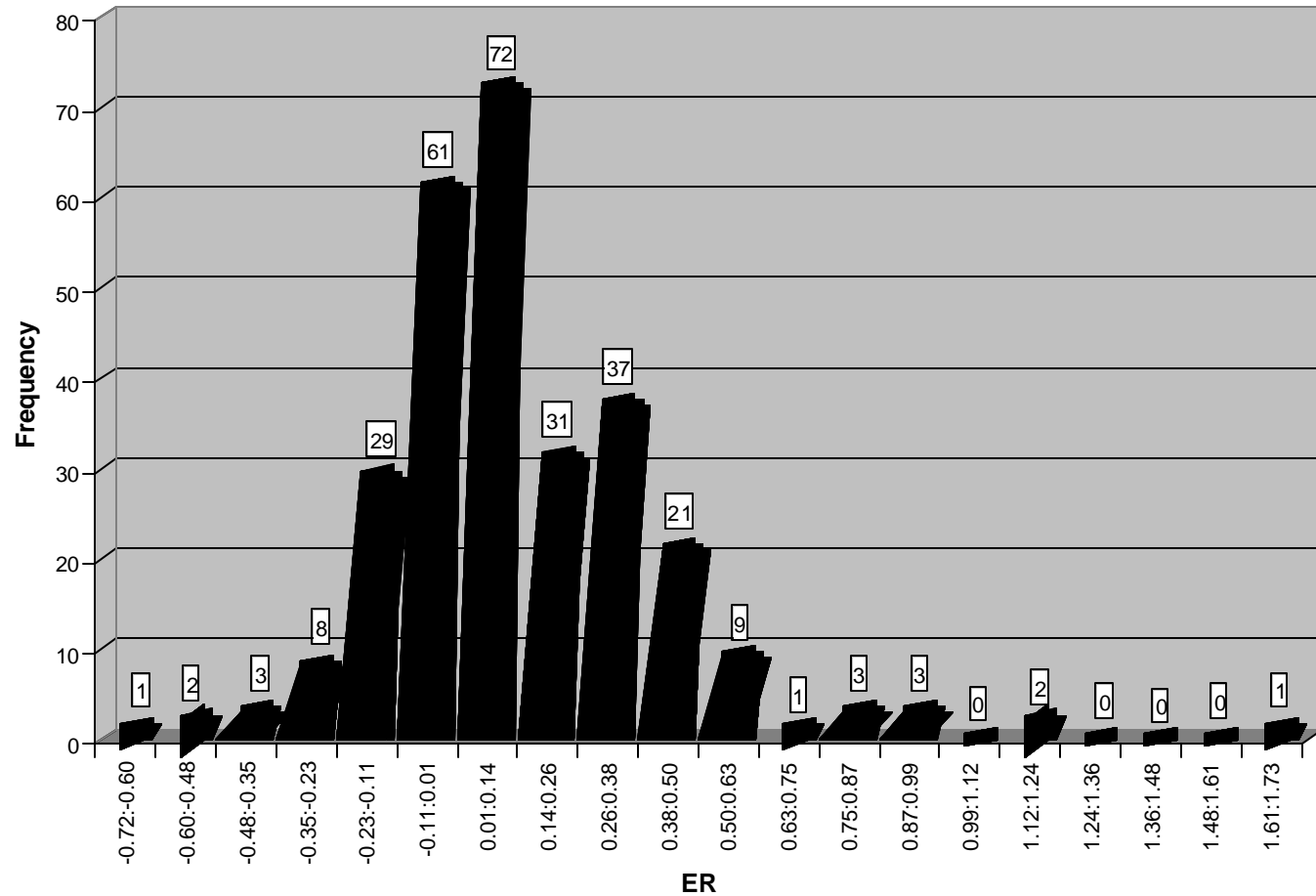
Figure 2: The distribution of allocations to investors in IPOs

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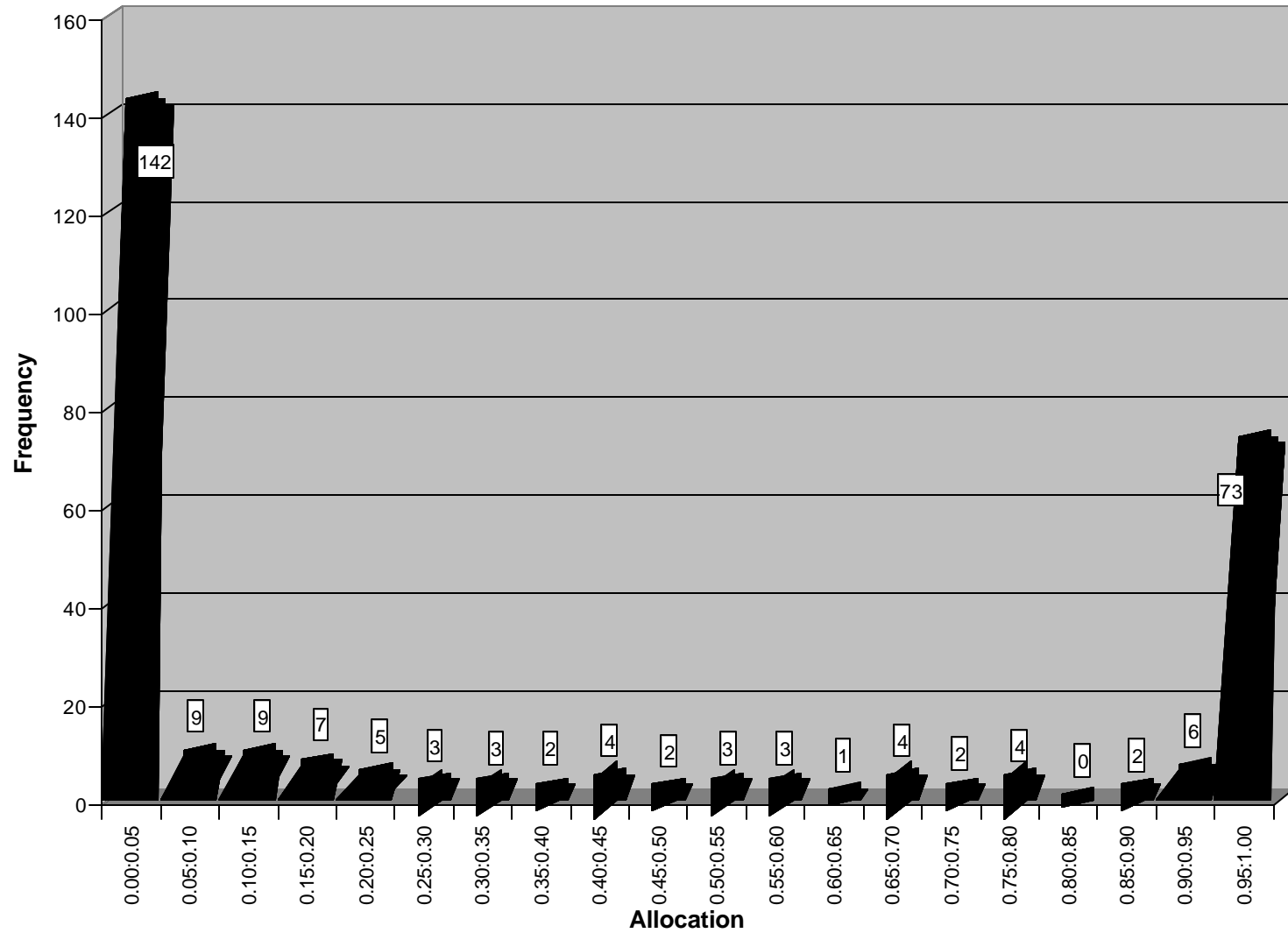
Figure 3: The distribution of allocation-weighted excess return in IPOs

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.
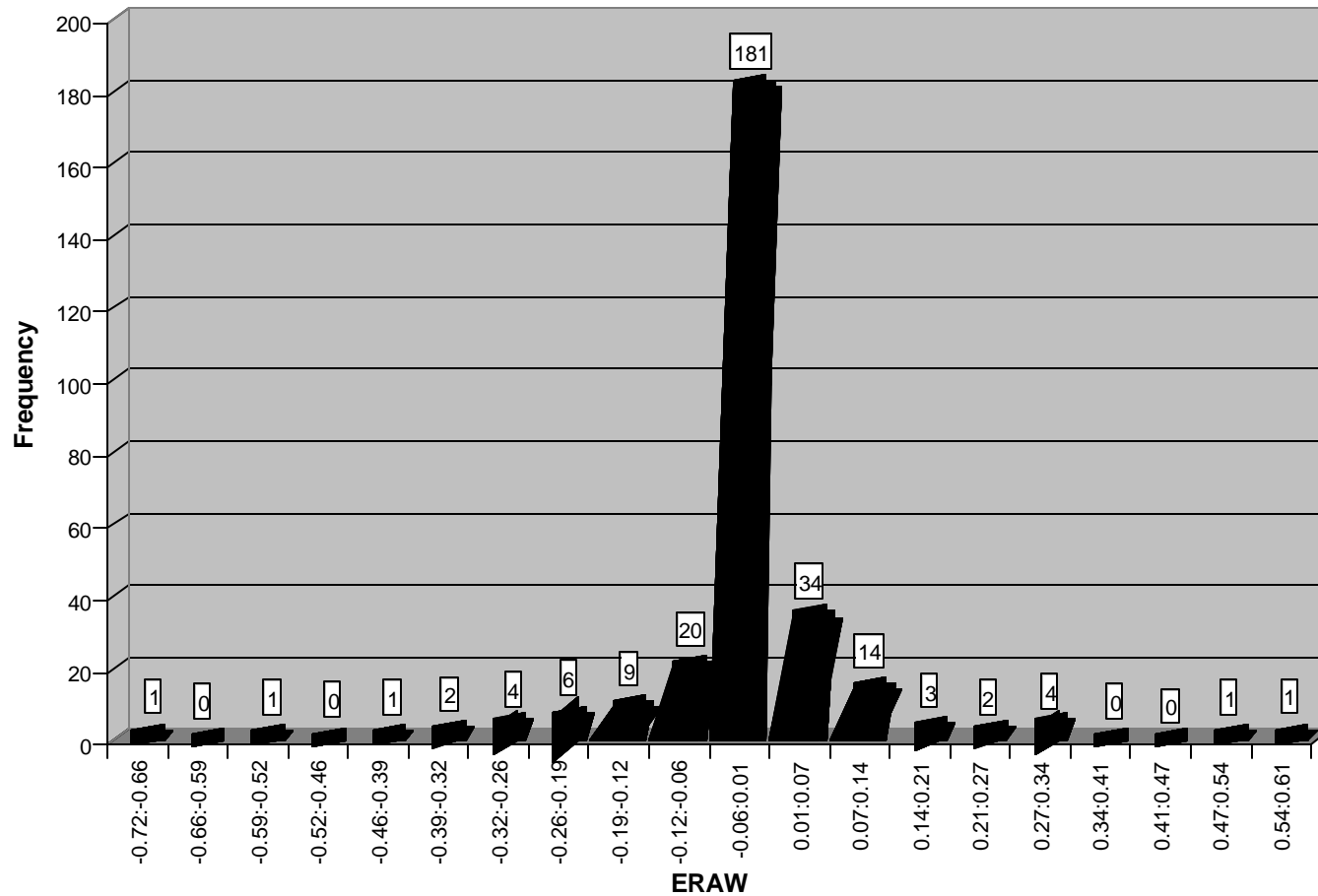
Figure 4: The allocation-weighted excess return against Allocation

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 $a = \frac{1}{2}/284$. The data presented here is for half the sample (142 IPOs) for which $ALLOC_j$ below its median.