Endowment Effects in the Field: Evidence from India's IPO Lotteries*

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Abstract

Winners of randomly assigned initial public offering (IPO) lottery shares are significantly more likely to hold these shares than lottery losers 1, 6, and even 24 months after the random allocation. This finding persists in samples of highly active investors, suggesting along with additional evidence that this "endowment effect" is not driven by inertia alone. The effect decreases as experience in the IPO market increases, but remains even for very experienced investors. These results provide field evidence derived from the behavior of 1.5 million Indian stock investors consistent with the laboratory literature that documents endowment effects for risky gambles.

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Numerous laboratory studies have documented that the simple fact of owning an object causes subjects to become reluctant to part with it. These lab findings of an "endowment effect" call into question the fundamental neoclassical assumption that preferences and beliefs are independent of ownership, and augur important implications for a wide variety of field contexts.

However, significant challenges confront the literature on endowment effects. Three important ones are that (1) market participants are likely to have more relevant experience than laboratory subjects, and the limited field evidence available suggests that experience appears to attenuate or even eliminate the measured endowment effect (see, for example, List (2003) and List (2011)); (2) lab findings of endowment effects appear sensitive to experimental procedures, which makes it difficult to generalize these results to the field (Plott and Zeiler, 2005); and (3) new lab evidence on the endowment effect shows that it also appears in gambles, and not just in physical objects with fixed payoffs (Isoni et al., 2011; Sprenger, 2015), though there is as yet little field evidence on the prevalence of the endowment effect for gambles.

Broadening the evidence base on endowment effects outside the lab faces a fundamental obstacle: it is essentially impossible to draw inferences in the absence of random assignment of endowments to market participants. Any comparison of agents' behavior without random assignment of ownership is potentially subject to selection bias – those who selected into ownership have almost surely done so because they value the object or gamble more in the first place.

To surmount this obstacle, we study a natural experiment in which millions of market participants outside of the lab are randomly assigned risky gambles. Owing to regulation, in many cases Indian initial public offering (IPO) shares are randomly assigned to applicants. This randomization means that winners and losers in these IPO lotteries should have virtually identical preferences, beliefs, and information sets before the shares are allotted. While lottery losers do not have the opportunity to buy the shares at the IPO issue price, they receive cash back which is equivalent to the IPO issue price.[1] Once the stock begins to trade freely, the groups of winners and losers have equal opportunities to trade in it. Given the equivalence of information sets and background characteristics induced by

[1] We refer to the price that lottery winners pay for the IPO stock as the "issue price," and the first price that the stock trades at on the exchange as the "listing price."

the random assignment, we should expect that the holdings of this randomly allocated stock should converge rapidly over time across the two groups. If randomly assigned ownership induces changes in valuation, however, we should see a divergence in the behavior of the randomly chosen winners and losers.

We document that the winners of IPO lotteries are substantially more likely to hold the randomly allocated IPO shares for many months and even years after the allocation. In our main results we find that 62.4 percent of IPO winners hold the IPO stock at the end of the month after listing, while only 1 percent of losers hold the stock. Six months after the lottery assignment the gap decreases slightly, to 46.6 percent of winners holding the stock and 1.6 percent of the losers holding the stock, but even 24 months after the random assignment we find that winners are 35 percentage points more likely to hold the IPO stock than losers.

For our results to be a manifestation of the endowment effect, randomly induced ownership must cause winners' willingness to accept (WTA) to become greater than losers' willingness to pay (WTP) for the IPO stock.[2] Accepting this interpretation requires ruling out explanations for the winner-loser divergence that do not produce a gap between winner WTA and loser WTP. Perhaps the most plausible alternative is that lottery winners and losers face formal or informal costs of trading which are large enough to cause the divergence in holdings that we observe. In our setting, such costs might include brokerage commissions, transactions costs, taxes, or inertia generated by cognitive processing costs of paying attention to the stock, accessing the brokerage account, or placing trades.

We study this issue in detail, developing a formal framework which we describe later in the paper, but note here that a number of empirical findings are inconsistent with this explanation. First, we find that the divergence persists strongly even as we look at investors who made more and more trades on average prior to the IPO – lottery winners at the 99th percentile of the trading distribution (more than 30 trades per month on average in the six months prior to the lottery) are still approximately 30 percent more likely to hold the stock than losers. Second, we find a large divergence amongst the sub-sample of lottery winners who make a large number of trades of sizes less than or equal to the

[2] WTA is the lowest price that a seller is willing to sell at. WTP is the highest price a buyer is willing to pay.

position size of the IPO stock in the months after the IPO.[3] Third, we find that even in sub-samples of lottery winners and losers that have actively sold another previously allotted IPO stock, winners are still substantially more likely to hold the current IPO stock than losers, casting doubt on the idea that the divergence is due only to investors who do not pay attention to the IPO stocks in their portfolio. Fourth, we find that lottery winners are more likely to make the active decision of buying additional shares of the IPO stock than lottery losers, which is consistent with the idea that lottery winners have a higher WTP for the stock than lottery losers. This is particularly difficult to explain via transactions costs, even if such costs are investor, time, and security-specific. Finally, lottery losers are not more likely to purchase another substitute stock, confirming that the winner-loser divergence in ownership is not undone by transactions in other stocks.

Overall, we conclude that most reasonable models of inertial behavior driven by costs of trading are unlikely to explain our results.[4] As we report in detail later, we also find little evidence to suggest that wealth effects, capital gains taxes, information acquisition costs, or other alternative explanations can explain our results.

We do find that the divergence in holdings attenuates substantially for the most experienced traders in our setting, as in List (2003). For each investor, we observe the number of IPOs they have previously been allotted over the past 10 years, a measure of experience which varies from 0 previous experiences up to 30 previous experiences at the 90^{th} percentile of the distribution. Consistent with List (2003), we find a strong negative correlation between this experience measure and the difference in holdings between lottery winners and losers, even after controlling for many investor and IPO characteristics. However, while List (2003) finds that endowment effects become negligible amongst his sample of experienced traders (sports card dealers and very experienced non-dealers), we find substantial endowment effects even amongst investors who have participated in over 30 IPOs – on average these highly experienced winners still hold 27 percent of their lottery allotments at the end of

[3]These findings also assuage concerns that our results are being driven by "trade uncertainty"– the idea that investors are uncomfortable with trading in general and therefore stick to the status quo (Engelmann and Hollard, 2010).

[4]In related work, we find that lottery winners have a higher trading intensity of the non-IPO stocks in their portfolio than lottery losers, and tend to tilt their portfolios in the direction of the industry sector in which the IPO stock is situated, suggesting that winning the lottery appears to reduce the (cognitive) transaction costs associated with making trades (Anagol et al., 2015).

the month of randomly receiving the IPO, while losers hold 7 percent of the initial allocation.[5]

Our evidence of an endowment effect even for experienced participants is valuable, because there are many plausible ways that participants *could* learn to avoid the behavior that we observe. Given the large size and overall popularity of the IPO market in India, investors have ample opportunities to learn from more experienced peers, as well as from the universe of public sources (e.g., advice on IPO investing on the many IPO message boards).[6] Further, participants in our setting can use information gained through these avenues to plan their behavior in advance to eliminate endowment-effect behavior. For example, an investor could follow the simple rule of always selling the IPO allocation immediately after the stock lists, and always choosing not to purchase the IPO if they lose the lottery.[7] It is also worth noting that in our setting, participants can learn over a considerable length of time across multiple IPOs – i.e., given the shorter duration of lab experiments, it seems less likely that subjects in the lab would explicitly consider the counterfactual choice had they been allocated a different object. In our setting, a participant might experience winning the IPO lottery in one case, and losing in the other. It seems natural that experiencing both the "endowed" and "non-endowed" states would encourage the agent to demonstrate consistent behavior across the two, and it is therefore all the more surprising that experienced investors continue to exhibit divergent behavior based on random assignment of ownership.

We explore potential theoretical underpinnings for the endowment effect that we detect in our setting, noting that while carefully and cleverly designed laboratory experiments have been successful in distinguishing theoretical explanations of endowment effects,[8] our field setting (and very likely most field settings) does not allow for precise conclusions regarding mechanisms. Nevertheless, we check the extent to which leading theoretical models of the endowment effect generate additional predictions that are supported by the data.

[5]These results are also interesting in light of Haigh and List (2005), who find that professional futures traders exhibit greater myopic loss aversion and raise the possibility that market experience might exacerbate behavioral anomalies. Our evidence rejects the idea that more experienced market participants exhibit the endowment effect anomaly more strongly.

[6]See www.chittogarh.com for an example.

[7]Indeed, 38 percent of investors do follow this path, and (evaluated ex-post) benefit from it, as on average, cumulative returns on the IPOs in the sample, measured relative to the issue price, are -54% over the 12 months following the IPO.

[8]See, for example, (Engelmann and Hollard, 2010; Ericson and Fuster, 2014; Weaver and Frederick, 2012; Goette et al., 2014; Heffetz and List, 2014; Sprenger, 2015; Song, 2015).

A leading explanation for the endowment effect is that agents have reference-dependent preferences, as originally proposed by Kahneman and Tversky (1979).[9] Most of the empirical literature has focused on the case of consumption goods, where specifying the reference point as current ownership can lead to owners valuing goods more than non-owners. More recently, Kőszegi and Rabin (2006, 2007) propose a broader framework where the referent is the entire distribution of the agent's expected outcomes. This formulation makes the prediction that choices between gambles and certain amounts exhibit an "endowment effect for risk," that is, decision-makers endowed with a risky lottery will be less risk-averse regarding the lottery than decision-makers that are endowed with a certain amount, and considering the same risky lottery.[10] New lab work finds significant evidence for this effect (Sprenger, 2015).

Motivated by this literature, we develop two models which apply expectations-based reference-dependent preferences to our setting. The first of the two models in this class is the Sprenger (2015) "endowment effect for risk" model, in which agents evaluate the comparison between the IPO stock (which we treat as a risky gamble in the model) and cash. The second model in this class more closely matches features of our real-world experimental environment – agents in this augmented model evaluate both the initial risky gamble of the lottery assignment of the IPO, as well as the subsequent comparison between the IPO stock and cash. In both models, we find the range of parameter values (for the extent of loss aversion, the expected return on the stock, and in the second model, the expected probability of winning the IPO lottery) for which the same agent would choose to hold the stock if they won the lottery, but not purchase the stock if they lost the lottery.[11]

We find that both models that employ expectations-based reference-dependent preferences are able to deliver the endowment effect plan as a personal equilibrium (PE) within plausible parameter ranges. In both models, the endowment effect PE requires that agents expect medium-size returns

[9] See Pope and Schweitzer (2011) for field evidence on reference-dependent preferences, and Pope and Sydnor (2016) for a recent review of field evidence on behavioral anomalies more broadly.

[10] Put differently, agents endowed with a gamble and given the choice of a certain amount in the gamble's outcome support are predicted to exhibit near-risk-neutrality, while those endowed with the certain amount are predicted to exhibit risk-aversion when given the choice of taking the gamble.

[11] In the language of Kőszegi and Rabin (2006), we find the range of parameter values where we would observe an endowment effect in our experiment because agents are playing their "personal equilibrium" (PE) strategies. In several cases, we also consider whether the plan generates the highest expected utility of all possible PE plans, i.e., whether it is a "preferred personal equilibrium" or PPE.

on the risky gamble. These medium-size return expectations are achievable through a combination of beliefs about skewed payoffs on the lottery and beliefs about the likelihood of experiencing gains versus losses. Put differently, medium-size return expectations can be delivered either through small probabilities of large gains or through large probabilities of small gains.

In the augmented model which includes the initial risky gamble of the lottery assignment of the IPO, we also find that low anticipated probabilities of winning the lottery are more likely to generate the endowment effect. This is because the agent compares how she feels when she wins the lottery to how she feels when she loses, and as the probability of winning the lottery becomes higher, this comparison becomes less and less important because the agent's reference points are less and less affected by her expectations of losing the lottery. Consistent with this prediction, we find in the data that estimated endowment effects do become smaller as the probability of winning the lottery increases.

Next, we evaluate a different theoretical mechanism, in which the endowment effect is founded on agents' "aversion to bad deals" as in Weaver and Frederick (2012). In this model, lottery losers endogenously lower their valuation for the IPO stock because they often have to purchase it at a price higher than the price at which lottery winners purchase it.[12] The bad deals model predicts large endowment effects if the price lottery losers pay is far higher than the issue price, and small endowment effects when the trading price is close to the issue price. We find mixed evidence for this prediction. On the first day of trading, lottery losers almost never purchase the stock irrespective of the difference between the market price and the issue price. However, by the end of the first full month of trading, lottery losers do appear more likely to purchase IPO stocks with smaller gaps between the current market price and the issue price, particularly in samples of more active traders. That said, the estimated winner-loser divergence even for these small listing gain stocks does not go to zero.

Finally, we consider the possibility that the divergence in winner and loser holdings is an artefact of agents knowing that they are subject to a lottery allocation. For example, lottery losers might lower their WTP for the IPO stock simply because they lost the lottery – we dub this the "sour grapes"

[12] Note that a standard expected utility decision maker does not consider the issue price in choosing whether to purchase the stock as a lottery loser. She will just compare her valuation for the stock with the market price, and purchase if her valuation is higher.

hypothesis. A few features of the data suggest that this explanation is not the main driver of our results. First, we find that lottery losers are more, not less, likely to purchase the IPO stock that they lost in the lottery, when compared to their propensity to purchase a size-and-industry matched stock.[13] Second, under the sour grapes hypothesis, we might naturally expect that lottery losers would also have a distaste for future IPO lotteries. We find, however, that losers are only very marginally less likely than winners to apply for future IPO allocations.[14]

To summarize, we find evidence of an endowment effect for risky gambles in a major market outside of the laboratory. Even after controlling for IPO market and trading experience, many market participants act as if they have higher valuations for a gamble when they are randomly endowed with it. The results are inconsistent with the basic prediction of expected utility theory that valuations of gambles should be consistent across ownership versus non-ownership states of the world. Our evaluation of theoretical models points to reference-dependent utility models as the leading explanation for our results. For one, investors appear to behave as if they are averse to paying higher prices than the issue price, suggesting that they treat this price as a reference price. In addition, we find that the Kőszegi and Rabin (2006, 2007) models are able to rationalize our findings as a personal equilibrium,[15] indicating that our findings may be an "in-the-field" manifestation of the endowment effect for risk.

1 The Experiment: India's IPO Lotteries

Our experiment uses the Indian retail investor IPO lottery as a naturally occurring setting in which some agents are randomly endowed with an asset while others are not, and where we can observe agents' choices to trade the asset following the random endowment. In this section we describe the circumstances in which these lotteries occur (including a specific example), and in the next section

[13] Lottery winners purchase the matched stock at similar rates to the lottery losers, suggesting that there is nothing in particular that makes lottery losers dislike the matched stock.

[14] An analogous explanation in this category is that winners choose to hold the IPO stock because of some positive emotions associated with winning the lottery. This explanation also does not seem satisfactory; we find that investors tend to hold the IPO stock for very similar durations as their most recently purchased (non-IPO) stock. Taken together, these results suggest that our finding of an endowment effect in this setting is unlikely to be just an artefact of the experimental setting that we study.

[15] We note, as in Sprenger (2015), that the personal equilibrium (PE conditions) are supported by our results, but not the preferred personal equilibrium (PPE) refinement. We leave these details to the online appendix.

describe how they can be used to estimate endowment effects. We provide the precise details of the IPO lottery process and associated regulations in Appendix Section A.1.[16]

To summarize, these IPO lotteries arise in situations in which an IPO is oversubscribed, and the use of a proportional allocation rule to allocate shares would violate the minimum lot size of shares set by the firm. In these situations, the lottery is run to give investors who applied for shares their proportional allocation *in expectation*. The outcome of the lottery is that some investors who applied receive the minimum lot size, while others who applied receive zero shares. The fundamental reason for the lottery is that in India, regulations require that a firm must set aside 30% or 35% of its shares (depending on the type of issue) to be available for allocation to retail investors at the time of IPO. For the purposes of the regulation, "retail investors" are defined as those with expressed share demands beneath a preset value. At the time of writing, this preset value is set by the regulator at Rs. 200,000 (roughly US $3,400); this value has varied over time (see Appendix Section A.1).[17]

The share allocation process in an Indian IPO begins with the lead investment bank, which sets an indicative range of prices. The upper bound of this range (the "ceiling price") cannot be more than 20% higher than the lower bound (or "floor price"). Importantly, a minimum number of shares (the "minimum lot size") that can be purchased at IPO is also determined at this time. All IPO bids, and ultimately, share allocations, are constrained to be integer multiples of this minimum lot size.

Retail investors can submit two types of bids for IPO shares. Ninety-three percent of the sample submit a "cutoff" bid, where the retail investor commits to purchasing a stated multiple of the minimum lot size at the final issue price that the firm chooses within the price band. To submit the bid, the retail investor deposits an amount into an escrow account, which is equal to the ceiling of the price band multiplied by the desired number of shares. If the investor is allotted shares, and the final issue price is less than the ceiling price, the difference between the deposited and required amounts is refunded as cash to the investor.[18]

[16]As with many other details of regulation in the country, the Indian regulatory process for IPOs is quite complex. Several papers (e.g., Anagol and Kim, 2012; Campbell et al., 2015) have used this complexity of the Indian regulatory process to cleanly identify a range of economic phenomena.

[17]This regulatory definition technically permits institutions to be classified as retail when investing amounts smaller than the limit, but over our sample period, we verify using independent account classifications from the depositories that this very rarely occurs.

[18]The remaining investors in our sample submitted "full demand schedule" bids. In this type of bid the investor

Once all bids have been submitted the total levels of demand and supply of shares are set and regulation determines how shares will be allotted in the case that demand exceeds supply. We define retail over subscription v as the ratio of total retail demand for a firm's shares to total supply of shares by the firm to retail investors. There are then three possible cases:

1. $v \leq 1$. In this case, all retail investors are allotted shares according to their demand schedules.

2. $v > 1$, and shares can be allocated to investors *in proportion to their stated demands without any violation of the minimum lot size constraint*. There is no lottery involved in this case.

3. $v >> 1$ (the issue is substantially oversubscribed), and a number of investors under a proportional allocation scheme would receive an allocation which is lower than the minimum lot size. This constraint cannot be violated by law, and therefore, all such investors are entered into a lottery. In this lottery, the probability of receiving the minimum lot size is proportional to the number of shares in the original bid and lottery applicants receive their proportional allotment in expectation.[19]

This third case, in which the lottery takes place, provides the random variation that we exploit to test for the endowment effect. Far from being an unusual occurrence, in our sample alone (which is a subset of all IPOs in the Indian market over the sample period), roughly 1.5 million Indian investors participate in such lotteries over the 2007 to 2012 period in the set of 54 IPOs that we study.

The time line of the application and allotment process is as follows. Applications are received over a two-day period termed the "subscription period." Shares are allotted to the winner's accounts approximately 12 days after the applications are received. The shares typically list approximately 21 days after the subscription period. Refunds of the escrow amounts begin to be processed after the allotments are made, usually 14 days after the allotments are made. Lottery losers receive a complete refund on their escrow amounts.

specifies the number of lots that they would like to purchase at each possible price within the indicative range, once again depositing in escrow the maximum monetary amount consistent with their demand schedule at the time of submitting their bid, with a cash refund processed for any difference between the final price and the amount placed in escrow.

[19] Appendix Section A.3 shows a mathematical derivation of the probabilities of winning allotments based on the level of excess demand.

An Example: Barak Valley Cements IPO Allocation Process. Barak Valley Cements' IPO opened for subscription for the two day period October 29, 2007 through November 1, 2007. The stock was simultaneously listed on the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE) on November 23, 2007. The price that lottery winners paid for the stock, which we refer to as the "issue price" throughout the paper, was Rs. 42 per share. The price the stock first traded at on the market, which we we refer to as the "listing" price, was 62 rupees per share. The stock closed on the first day of listing at Rs. 56.05 per share, for a 33.45% listing day gain. The retail over subscription rate v for this issue was 37.62. Given this high v, all retail investors that applied for this IPO were entered into a lottery.

Appendix Table A.1.1 shows the official retail investor IPO allocation data for Barak Valley Cements.[20] Each row of column (0) of the table shows the share category c, associated with a number of shares applied for given in column (1), which, given the minimum lot size $x = 150$ for this offer is just cx. In this case, the total number of share categories (C) equals 15, meaning that the maximum retail bid is for 2,250 shares.[21] Column (2) of the table shows the total number of retail investor applications received for each share category, and column (3) is the product of columns (1) and (2). Column (4) shows the investor allocation under a proportional allocation rule, i.e., $\frac{cx}{v}$. Given that these proportional allocations are all below the minimum lot size of 150 shares, regulation requires the firm to conduct a lottery to decide share allocations.

Column (5) shows the probability of winning the lottery for each share category c, which is $p = \frac{c}{v}$. For example, 2.7% of investors that applied for the minimum lot size of 150 shares will receive this allocation, and the remaining 97.3% of investors applying in this share category will receive no shares. In contrast, 40.6% of investors in share category $c = 15$ receive the minimum lot size $x = 150$ shares. For this particular IPO, *all* retail investors are entered into a lottery, and ultimately receive either zero or 150 shares of the IPO. Column (6) shows the total number of shares ultimately allotted to investors in each share category, which is the product of x, column (2), and column (5). Columns (7) and

[20] These data are obtained from `http://www.chittorgarh.com/ipo/ipo_boa.asp?a=134`.

[21] The number of share categories is capped at 15 here because $C = 16$ would correspond to 2,400 shares, and a subscription amount of Rs. 100,800 at the issue price of Rs. 42. This subscription amount would violate the prevailing (in 2007) regulatory maximum retail investor application constraint of Rs. 100,000 rupees per IPO.

(8) show the total sizes of the winner and loser groups in each share category for the Barak Valley Cements IPO lottery, respectively.

It is perhaps easiest to think of our data as comprising a large number of experiments, in which each experiment is a share category within an IPO. *Within* each experiment the probability of treatment is the same for all applicants, and we exploit this source of randomness, combining all of these experiments together to estimate the average causal effect of winning an IPO lottery on future holdings of the IPO stock.

Data. When an individual investor applies to receive shares in an Indian IPO their application is routed through a registrar. In the event of heavy over subscription leading to a randomized allotment of shares, the registrar will, in consultation with one of the stock exchanges, perform the randomization to determine which investors are allocated. We obtain data on the full set of applicants to 85 Indian IPOs over the period from 2007 to 2012 from one of India's largest registrars. 54 of these IPOs had at least one randomized share category. This registrar handled the largest number of IPOs by any one firm in India since 2006, covering roughly a quarter of all IPOs between 2002 and 2012, and roughly a third of all IPOs over our sample period.[22] This paper studies only the category of retail accounts, as the IPO lottery only applies to this group of investors. For each IPO in our sample, we observe whether or not the applicant was allocated shares, the share category c for which they applied, the geographic location of the applicant by pincode (similar, but larger than, zipcodes in the U.S.), the type of bid placed by the applicant, the share depository in which the applicant has an account (more on this below), whether the applicant was an employee of the firm, and a few other application characteristics.

Our second major data source allows us to characterize the equity investing behavior of these IPO applicants. We obtain these data from a broader sample of information on investor equity portfolios from Central Depository Services Limited (CDSL). Alongside the other major depository, National Securities Depositories Limited (NSDL), CDSL facilitates the regulatory requirement that settlement

[22] Appendix Figure A.1.1 shows that our sample of IPOs tracks the aggregate Indian IPO waves, with a decline in 2009, and high numbers of IPOs in 2008 and 2010. Appendix Table A.1.2 presents summary statistics on our sample of IPOs. Our sample accounts for 22% of all IPOs over this period by number, and US$ 2.65 BN or roughly 8% of total IPO value over the period.

of all listed shares traded in the stock market must occur in electronic form.[23] Every applicant for an IPO must register to open (or already have) an account with either of the two depositories (CDSL and NSDL), as the option to receive allocated shares in an IPO in physical form does not exist. We match the IPO applications data to the CDSL accounts data using anonymous identification numbers of household accounts from both data sources. We verify the accuracy of the match by checking common geographic information fields provided by both data providers such as state and pincode.[24] When adjusted for per-capita GDP differences between the US and India, the account value distribution and trading activity for the universe of investors in the CDSL data and the lottery sample are similar to those in the US (see Appendix Figure A.1.3 (a) and (b)).

All CDSL trading accounts are associated with a tax related permanent account number (PAN), and regulation requires that an investor with a given PAN number can only apply once for any given IPO.[25] Thus no investor account may simultaneously belong to both the winner and loser group, or be allocated twice in the same IPO. However, it is possible that a household with multiple members with different PAN numbers could submit multiple applications for a given IPO in an attempt to increase the household's likelihood of winning. While we do not directly control for this possibility, we believe that this is unlikely to materially affect our inferences, as we discuss in more detail in the section covering potential explanations for our results.

Using IPO Lotteries to Estimate Endowment Effects. The method of estimating the endowment effect in our natural experiment bears important similarities and differences to the laboratory methods used before. Broadly speaking, our method resembles the "exchange paradigm" of endowment effect experiments (Ericson and Fuster, 2014). In this paradigm, subjects are randomly assigned to receive one of two objects A or B of approximately equal value (e.g. a mug and a pen). Later in the experiment the subjects are given the opportunity to trade for the object they were not originally endowed. The

[23] CDSL has a significant market share – in terms of total assets tracked, roughly 20%, and in terms of the number of accounts, roughly 40%, with the remainder in NSDL. While we do also have access to the NSDL data (these data are used extensively and carefully described in Campbell et al., 2014), we are only able to link the CDSL data with the IPO allocation information.

[24] We are able to match 99.5 percent of our IPO lottery applicants to our data on portfolio holdings.

[25] In July 2007 it became mandatory that all applicants provide their PAN information in IPO applications. (SEBI circular No.MRD/DoP/Cir-05/2007 came into force on April 27, 2007. Accessed at http://goo.gl/OB61M2 on 19 September 2014.) We confirm there are no violations of this regulation in our data, by checking across all brokerage accounts associated with the anonymized tax identification number of each investor.

extent to which the holdings depart from equal proportions in groups initially assigned goods A and B provides a quantitative estimate of the endowment effect.

As a starting point, it is useful to think of good A as the IPO stock which is randomly assigned to our lottery winners, and good B as the cash from the escrow account that is returned to lottery losers. For identification purposes, the key similarity of our setting with the laboratory exchange paradigm is that the subjects who receive the IPO stock are randomly chosen. This removes the standard selection problem of owners of objects having higher valuations for the object than non-owners. The second important similarity is that we can subsequently observe the holding behavior of the randomly endowed objects in a setting where the participants can trade at relatively low cost; when the stock lists on the market, this is analogous to the experimenter giving the laboratory subjects the opportunity to exchange. The final important similarity is that to estimate the size of the endowment effect, we compare the fraction of lottery winners who hold the IPO stock to the fraction of lottery losers who hold the IPO stock after both groups have had the opportunity to exchange. In our setting as well as in the laboratory exchange paradigm, it is not possible to estimate the magnitude of the gap between the WTA of owners and the WTP of losers. However, we argue that the holding behavior of stock investors is an intrinsically interesting outcome in itself (see Baker et al. (2007), for example), even if the WTA-WTP gap is small.

Our natural experiment has a number of important differences with the laboratory exchange paradigm, and several of these differences make it relatively harder for us to identify endowment effects. First, the participants in our natural experiment who are randomly endowed with the IPO stock also receive a wealth shock relative to the lottery losers, since winners are allowed to purchase the IPO stock at the issue price and then sell it at the listing price.[26] In contrast, in exchange paradigm experiments, the objects are typically chosen to be of equal value, so there is no wealth shock.

Second, in exchange paradigm experiments, the explicit/formal cost of trading is zero. In our setting, there are monetary costs of transacting, such as brokerage fees and securities transactions

[26]Lottery losers cannot purchase the stock at the issue price, meaning that the change in value of the allotted stock between listing and issue prices constitutes a wealth gain (or loss) for lottery winners (62 dollars on average). The wealth gain is not equal to the total amount of the endowment because lottery losers receive a refund equal to the amount of the allotted stock, valued at the issue price.

taxes. The presence of these costs makes it possible that a divergence in lottery winner and loser holdings could emerge even in the absence of a WTA-WTP gap. This motivates us to focus heavily on the extent to which such costs can explain the differences we find.[27]

Third, subjects in exchange paradigm experiments are explicitly prompted about whether they would like to trade one good for the other. This makes it plausible to believe that laboratory subjects have actively thought about whether they would like to exchange good A for good B (although it cannot, of course, guarantee that this is the case). In our setting, there is no experimenter encouraging the investor to actively consider whether they want to sell (lottery winners) or buy (lottery losers) the IPO stock after it begins to trade. Thus, we need to be careful to rule out the possibility that costs associated with paying attention to the IPO stock might generate differences in the holding behavior of winners and losers even in the absence of an endowment effect.

Fourth, participants in our natural experiment know that they have been randomly endowed the IPO stock or returned the cash. Subjects in exchange paradigm experiments are typically not told that they might have received the other object. This opens the possibility that changes in WTA or WTP could be induced by participants' reactions to the event of either winning or losing the lottery itself, separately from the act of owning the object. For example, lottery losers might lower their valuation of the IPO stock when the state of winning the IPO lottery becomes unattainable – the "sour grapes" hypothesis. We also note here that the presence of any such factor might make it *less* likely to observe a divergence in holdings across winners and losers, if both groups realize that their ownership of the stock is only due to chance.

Our natural experiment also has a few identification advantages. The setting avoids four specific laboratory features that have been highlighted as spuriously producing endowment effects in Plott and Zeiler (2005): 1) the endowed object is placed physically in front of the subject, and therefore endowed subjects might gain more information about the endowed versus non-endowed object,[28] 2) the endowed object is called or interpreted as a gift, 3) the procedure measuring WTA and WTP

[27]While exchange experiments have no monetary costs of trading, they of course may have important informal/psychological costs of engaging of trading.

[28]For example, in List (2003), sports cards traders were physically given the sports memorabilia, asked to fill out a survey, and then prompted for whether they want to trade.

is not properly incentivized, and 4) the subject is not guaranteed anonymity when making choices. In our setting, 1) lottery winners do not have access to any information about the IPO security that lottery losers cannot obtain through publicly available sources, 2) there is little reason to believe winners would frame receiving the IPO stock as a gift given that they put down large escrow amounts to apply for the shares, and have to pay the issue price, 3) we measure the endowment effect by measuring the actual divergence in holdings of the IPO stock, which investors are clearly incentivized to choose optimally, and 4) the anonymous nature of financial markets makes it unlikely that investors are concerned about others observing their choices.

Three other advantages of our setting are worth noting. First, participants in our setting have a far longer time period to consider their potential decisions regarding the endowed gamble, including the period before the allotment (when they could make a plan regarding what to do in the event of winning or losing the lottery); the period immediately following the allotment; and the many months when we can track their behavior after the stock starts trading. For example, it would be easy for lottery applicants to avoid the endowment effect in our setting by making a plan to sell the stock immediately after it lists if they win the lottery, and to not buy the stock if they lose the lottery. In contrast, subjects in exchange experiments typically consider these choices for much shorter periods of time. For example, in the List (2003) study, subjects were given a piece of sports memorabilia by the experimenter, took a five minute survey, and then were immediately asked if they would like to trade for another piece of sports memorabilia. Second, our participants have many more learning opportunities to exploit during this longer time period (such as peers, message boards, broker advice, etc.) that subjects in the previous field and lab experiments do not have access to. In this sense our results can be viewed as a joint test of the hypothesis that individual market participants demonstrate an endowment effect, and also that market sources of information do not eliminate this anomaly. Third, because we observe the investor's full portfolio of trades, we can observe whether the investor actively chooses to buy more of the randomly endowed gamble, in addition to whether they hold the randomly endowed gamble. This is a useful direct test that most laboratory and field experiments do not permit.

2 Documenting the Winner-Loser Divergence

We estimate the causal effect of winning an IPO lottery on various measures of holdings of the IPO stock for each (event) month t, by estimating cross-sectional regressions of the form:

$$y_{ijc} = \alpha + \rho I_{\{success_{ijc}=1\}} + \gamma_{jc} + \varepsilon_{ijc}. \quad (1)$$

Here, y_{ijc} is an outcome variable of interest, such as an indicator for whether the account holds the IPO stock, for applicant i in IPO j, share category c. $I_{\{success_{ijc}=1\}}$ is an indicator variable that takes the value of 1 if the applicant was successful in the lottery for IPO j in category c (investor is in the winner group), and 0 otherwise (investor is in the loser group). ρ are the estimated treatment effects in each event-month t. γ_{jc} are fixed effects associated with each IPO share category experiment in our sample. Angrist et al. (2013) refers to these experiment-level fixed effects as "risk group" fixed effects. Conditional on the inclusion of these fixed effects, variation in winning the lottery is random, meaning that the inclusion of controls should have no effect on our point estimates of ρ. We run this regression separately for different months after the IPO stock is allotted to examine how the winner-loser divergence varies over time.[29]

Randomization Check. Table 1 presents summary statistics and a randomization check comparing our lottery winner and loser groups. Columns (1) and (2) present the means of variables listed in the row headers in winner and loser groups respectively, and Column (3) presents the difference across the two samples. All of these variables are measured the month before allotment of the IPO. If the allocation of IPO shares is truly random, we would expect few statistically significant differences across winner and loser groups prior to the assignment of the IPO shares. Column (4) calculates the percent of our 383 share category experiments in which the winner and loser groups were significantly

[29] See Chapter 3 of Angrist and Pischke (2008) for a discussion of how regression with fixed effects for each experimental group identifies the parameter of interest using only the experimental variation. Angrist (1998) shows that our estimated treatment effect ρ is a weighted average of the treatment effects from each separate share category experiment. Intuitively, the regression weights give more importance to experiments in which the probability of treatment is closer to $\frac{1}{2}$, and experiments with larger sample sizes – experiments in which there are many accounts in both treatment and control groups. Note that in our summary statistics tables described below and throughout the remainder of the paper, mean values for lottery winner and loser groups are calculated across share categories using the same weighting scheme implied in our regression.

different at the 10% level. Under the null hypothesis that winning the lottery is random, we expect that roughly 10% of these experiments will exhibit a significant difference at the 10% level.

The first variable we check for balance on is whether accounts that won the current lottery were also more likely to have been successful in receiving IPO shares in the past. If it was possible to "game" the lottery and increase one's probability of winning we would expect current winners to have also been more successful in the past.[30] Table 1 shows that virtually identical fractions (38%) of both winner and loser investors applied to an IPO with our registrar, or were allotted shares in an IPO not covered by our registrar, in the month prior to allotment.

The next set of variables describes the trading behavior of our winner and loser groups. 68.2% of lottery applicants made a trade in the month prior to the lottery. Half of the accounts make between 1 and 10 trades in the month prior to the IPO, and 5 percent of accounts made over 20 trades in that month. The next variables present summary statistics on the fraction of accounts that made trades in position sizes less than or equal to the value of the IPO allotment. This is useful to look at because the lottery allotments are the minimum lot size, so we would like to have a sense of how common it is for our lottery participants to trade in such "small" position sizes. In fact, we find that 63.5% of applicants made a trade of a size less than or equal to the size of the lottery allotment in the month prior to the IPO. This result shows that while the lottery allotments appear small in dollar terms, it is actually very common for these investors to trade in amounts that are of equal or smaller size.[31] We also look at the propensity of both winner and loser group investors to "flip" IPOs that they had been allotted in the past. We define flipping as selling an allotted IPO in the allotment month. We find that close to 30% of investors in both winner and loser group investors have this propensity, which is striking in light of our later results on the divergence between the post-allotment ownership patterns of winners and losers.

[30] In the case of IPOs for which our data provider was the registrar, we can directly measure whether or not an account *applied* to an IPO in each of periods $+1$ to $+6$. For IPOs where our data provider was not the registrar, we can observe whether the account was *allotted* shares since we see allotments for the entire universe of IPOs from the CDSL data. We set the outcome variable to one in either case – if we see an application for IPOs for which our data provider was the registrar, or if we see an allotment for IPOs not covered by our registrar – and zero otherwise. We focus on this combined measure because it includes all of the information available to us.

[31] The fraction of experiments that show significant differences on the dummy variables for making greater than ten transactions less than the allotment size are large primarily in experiments that have small sample sizes. The large sample basis for this statistical test is less applicable in these cases.

The remaining rows of the table summarize other account characteristics. 78% of winner and loser investors had an account value greater than zero in the month prior to the IPO. Portfolio value amounts are highly skewed so we transform this variable using the inverse hyperbolic sine function[32] – we find that the mean (US$ 530 on average) and distribution of portfolio values are very similar across winner and loser accounts. Winner and loser accounts on average hold 9 securities in their portfolio before allotment. Approximately 30% of accounts are less than six months old, 33% are between 7 and 25 months old, and 37% are over 25 months old.

Overall, we find that the differences across winner and loser groups are small and typically not statistically significant at standard levels. The fraction of experiments with greater than ten percent significance is around ten percent. Given the similarity of winner and loser groups across this wide set of background characteristics, we confirm that the IPO shares allocated through the lottery mechanism are indeed randomly assigned to investors.

Characterizing the Treatment. Table 2 characterizes the application and allotment experience the investors in our analysis received upon being randomly chosen to receive IPO shares. Column (1) of the table shows the mean across all investors in the winner groups of IPOs in our 383 share category experiments for each of the variables listed in the row headers. Columns (2) through (6) present the percentile of each variable in terms of the distribution across all of the experiments.[33] On average, both lottery winners and losers put 1,751 dollars into an escrow account to participate in the lottery (row 1, Table 2). Lottery winners receive an average of 150 dollars worth of the IPO stock in the IPO lottery (row 3). They also receive an instant gain of 62 dollars on average, because IPO stocks' listing price is 39 percent higher than the issue price on average (row 5). Lottery losers cannot purchase the stock at the issue price, so the average endowment that the winners receive (which the losers do not) is 212 dollars (150 + 62) of the IPO stock. Both winners and losers get refunds from their escrow accounts of approximately 1,600 and 1,750 dollars, respectively.

[32] $\sinh^{-1}(z) = \log(z + (z^2+1)^{1/2})$. This is a common alternative to the log transformation which has the additional benefit of being defined for the whole real line. The transformation is close to being logarithmic for high values of the z and close to linear for values of z close to zero. See, for example, Burbidge et al. (1988) and Browning et al. (1994).

[33] We first calculate the mean within each experiment, and then report the corresponding percentile across the experiments. For example, the median share category experiment had a mean application amount of 792 dollars (first row of Table 2).

Full Sample: Graphical Analysis. Figure 1 presents our main result in graphical form. Figures 1a and 1b plot the fraction of winners (black triangles) and fraction of losers (green circles) that hold the IPO stock in a given share category experiment at the end of the first day of trading. Figure 1a plots this measure against the percentage listing return on the x-axis, while Figure 1b uses instead the dollar value of the listing gain on the x-axis.[34] Figures 1c and 1d plot the fraction that hold the IPO stock at the end of the first full month post-listing on the y-axis. Figure 1c has on the x-axis the percentage return on the stock to the end of the first month, and Figure 1d replaces this with the change in the dollar value of the IPO allotment over the same interval on the x-axis. All four figures show a sizeable gap between between the holding rates for lottery winners and lottery losers, consistent with the presence of a valuation gap between winners and losers.[35] In Figures 1c and 1d we also observe that lottery winners are less likely to hold the stock as the stock's realized return increases; this is consistent with the well-known "disposition effect" first uncovered by Shefrin and Statman (1985).[36]

Full Sample: Estimation Results. Table 3 presents our main estimates. The first column presents statistics as of the end of the first day of trading ("Listing Day"). The remaining columns show the portfolio behavior observed at the end of each event month following the IPO listing (month zero is the listing month). Each row employs a different measure of the holdings of the IPO stock. Within each row header, the first and second rows present the estimated weighted mean of the variable in the winner and loser group respectively and the third row presents the estimated $\hat{\rho}$ from equation 1, i.e., the weighted difference between winner and loser group experimental means.

The first row considers an indicator for whether the account holds any of the IPO stock as the dependent variable. At the end of the first day of trading, we find that approximately 70 percent of lottery winners hold the IPO stock, while only .007 percent of losers hold the IPO stock. The difference is significant at the 1 percent level. One way to interpret this result is that approximately 30 percent of applicants, on average, do not show an endowment effect because their behavior is

[34]The listing return is the percentage price change from the price the lottery winners pay for the stock (issue price) to the first trading price (listing price).

[35]Many of the vertically aligned points represent different share categories of the same IPO. We exploit this variation later in testing how the winner-loser divergence varies with the probability of winning.

[36]An endowment effect in our setting is conceptually distinct from the disposition effect. It is possible that owning a stock has a causal effect on the investor's valuation of it regardless of whether an investor's experienced return on a stock affects their propensity to sell.

consistent regardless of whether they randomly won or lost the lottery. In contrast, 69.3 percent of applicants demonstrate an endowment effect at the end of the first day.[37]

At the end of the listing month (0), lottery winners are 62 percent more likely to hold the IPO stock than lottery losers. This divergence declines to 46 percent at the end of six months, with all differences significant at the 1 percent level. The loser group means show that it is relatively rare for lottery losers to own the stock – on average 1 percent of lottery losers own the IPO stock in the month in which it lists, this number only rises to 1.6 percent six months post-listing.

The second row header defines the dependent variable as the fraction of the potential IPO allotment that the account holds. For example, if winners in a particular share category lottery won ten shares and a given account holds five shares, the dependent variable would be defined as 0.5. For lottery losers this variable is also defined as the number of shares of the IPO stock they hold divided by the allotment they *would* have received had they won the lottery. For example if winners won ten shares, then a loser account that chose to purchase five shares on the market would have this measure equal to 0.5. For this measure, the divergence is slightly smaller at the end of month 1, but otherwise very similar to the first row. However, a comparison of lottery loser means across the first and second variables reveals that conditional on holding the IPO stock, lottery losers choose to hold a substantially larger fraction than the lottery allotment. In particular, Column (1) for month 0 shows that one percent of the lottery losers hold the stock, but their average fraction of allotment is 4.4 percent, implying that lottery losers who choose to own the stock purchase roughly four and a half times the amount of lottery allotment.[38]

The third row of the table is an indicator for whether the account holds exactly the number of shares allotted to winners in the relevant share category. Results here are similar to those in the first row, suggesting that most of the divergence between winners and losers arises from lottery winners continuing to hold initial allotments, while losers are unlikely to purchase the exact allotment they did

[37] We only present the first day results for the indicator for holding the IPO stock (I(Holds IPO Stock)) because this variable is the most reliably estimated given our data. Appendix A.7 describes the assumptions we need to make to determine whether an account held the IPO stock at the end of the listing day using our monthly holdings data.

[38] Suppose there are 10,000 lottery losers, the lottery allotment (to winners) was 10 shares, and 100 losers purchase the stock (1 percent). Also suppose that those 100 losers choose to purchase 50 shares. Then, the average fraction of the allotment held by lottery losers will be 5 percent (.01*5+.99*0 = .05).

not receive in the lottery.

The fourth row shows the US$ value of the IPO stock held in the portfolio at the end of the month. Lottery winners hold US$ 108 more of the stock than losers on average at the end of the first month, US$ 84 more at the end of the second month, and US$ 55 more at the end of the sixth month. This measure includes differences in chosen holdings between winners and losers as well as returns earned on those shares, meaning that some of the decline in this measure is attributable to significant negative returns on these IPO stocks on average, as we describe below. The fifth row shows the weight of IPO stock in the investor's portfolio, and shows that lottery winners hold 13 percent more of their portfolio in the IPO stock in month 0, which remains substantially higher at 6 percent six months after allotment.

The final rows of the table show average percentage returns to holding the IPO stock to the end of each month. On average the listing return is 42 percent. The next two rows show cumulative returns from holding the stock assuming that the stock was (1) won in the lottery, or (2) purchased at the listing price, and the final row shows the average returns from holding the Indian market portfolio measured over the same intervals. The returns data show that lottery winners on average lost money based on their choice to continue to hold the stock after it was initially listed, since (raw or market-adjusted) returns measured from the listing price are large and negative. In this sense, lottery losers in our sample make a relatively good decision (on average) to not purchase these IPO stocks at the first trading price. Clearly, what constitutes a good decision depends on the realization of returns in any particular sample, but the key result is that the two groups chose to make substantially *different* decisions about holding the stock.[39]

Appendix Table A.1.4 extends the analysis to 24 months after the lottery.[40] We find that even 24 months after allotment, lottery winners are 36 percent more likely to hold the IPO stock than the lottery losers. However, lottery losers' propensity to hold the stock stays relatively constant, at around 1.5 to 1.7 percent over these 24 months.

[39] For example, if this pattern of negative post-issue returns is predictable, then we would expect *both* lottery winners and losers to choose not to hold the stock after listing.

[40] The results for periods one and four months after IPO listing are slightly different from those in Table 3 because we restrict this analysis to those IPOs where we can observe the portfolios of lottery winners and losers at least 24 months after the IPO allotment.

3 Standard Expected Utility Explanations

In this Section we evaluate possible explanations for the large divergence in holdings of the IPO lottery winners and losers, assuming that winners and losers have the *same* distribution of valuations for the stock. These explanations can generate our empirical results even in the absence of an endowment effect.

Inertia Associated with Costs of Trading. We evaluate the extent to which our results can be explained by inaction induced by the costs associated with implementing a trade.[41] We begin with a model of inertial behavior that arises due to such costs (as separate from inertia induced by an endowment effect) to guide our empirical evaluation.

Let w^a_{ijt} represent investor i's willingness to accept (WTA) for stock j at time t. This level of WTA could be due to portfolio diversification motives, liquidity shocks, psychological factors, or anything else that determines whether the investor wants the stock in her portfolio. Let w^p_{ijt} be that same investor's willingness to pay (WTP) for the stock. Because this model does not include an endowment effect, $w^a_{ijt} = w^p_{ijt}$ for all investors i, for all stocks j, at any time t.

Now assume that c captures all costs associated with making a trade in the stock. This includes the cognitive cost of paying attention to the stock or to the act of trading, standard monetary costs (brokerage commissions, transactions costs, and security transaction taxes), nuisance factors (lost brokerage account password), etc. Moreover, c also includes non-rational costs that might drive inertia, such as costs of dealing with self-control problems that lead to procrastination.[42]

The presence of this cost c can induce inertia that inhibits trading, both when investors hold a stock as well as when they are contemplating buying a stock. Let p_{jt} be the market price of stock j at time t. A potential seller will choose to sell the stock if the revenue from selling, including the transaction cost, is greater than their WTA: $p_{jt} - c > w^a_{ijt}$. Rewriting this inequality, the agent sells

[41] Substantial evidence exists that in practice investors are sluggish, acting as if they face significant costs associated with taking action (Baker et al., 2007; Mitchell et al., 2006; Madrian and Shea, 2001) Recent papers have attempted to characterize optimal decision rules in the presence of both standard fixed costs and information processing costs – see, for example, Alvarez et al. (2013), Abel et al. (2013) and Andersen et al. (2015).

[42] In Appendix A.6. we present data on the levels of brokerage commissions and security transactions taxes, which are the two main forms of monetary transaction costs. We find both of these to be very low, with commissions ranging from .3 to .9 of a percent per trade and security transaction taxes of .145 of a percent.

if $p_{jt} - w^a_{ijt} > c$. Intuitively, if the gap between the market price and the agent's WTA exceeds the cost of selling, the agent will sell. Given a WTA amount w^a_{ijt}, the agent is less likely to sell as the transaction cost increases. Similarly, a potential buyer with WTP w^p_{ijt} will choose to purchase the stock if $w^p_{ijt} - c > p_{jt}$. The agent is less likely to buy as the transaction cost increases.

We now apply this framework specifically to lottery winners' and losers' choices of whether to hold, sell, or buy the IPO stock under different assumptions about transactions costs.

Case 1: No Costs of Trading. Let $j = \gamma$ denote the IPO stock. Under the assumption of no transactions costs, a lottery winner i will choose to hold the IPO stock if $w^a_{ijt} > p_{jt}$. A lottery loser i will choose to hold the stock if $w^p_{ijt} > p_{jt}$. Given that $w^a_{ijt} = w^p_{ijt}$ in this model, in this case an investor i will make the same decision regarding whether to hold the stock regardless if she won the lottery. Further, due to the randomization in our natural experiment, the distributions of WTA for winners and WTP for losers will be identical, and the fraction of lottery winners and losers holding the IPO stock will be the same. Under this assumption, our baseline results (Figure 1), in which we detect a divergence between the behaviour of 1,561,497 winners and losers (treatment: 468,519, control: 1,092,977), directly reflect a gap in WTA and WTP across winners and losers.

Case 2: Investor Specific Transactions Costs. Now consider the assumption that costs of trading are individual specific, $c = c_i$ for each investor i. In this case, a lottery winner i will choose to hold the IPO stock if $w^a_{ijt} > p_{jt} - c_i$. A lottery loser i will choose to hold the stock if $w^p_{ijt} > p_{jt} + c_i$. These conditions show that the same investor i could potentially make a different decision about whether to hold the stock based on whether they won the lottery. In particular, any investor's whose valuation satisfies the condition $p_{jt} - c_i < w^a_{ijt} = w^p_{ijt} < p_{jt} + c_i$ will choose to hold the stock as a lottery winner, but not choose to hold the stock as a lottery loser.

This issue becomes quantitatively less important as we focus on samples of investors with relatively low costs c_i. A simple way to do this is to note that investors with low c_i will have high trading volume in *all* stocks j. To understand this idea better, consider a seller in the model who owns N

stocks. The total number of stocks N_s that they will sell is:

$$N_s = \sum_{j=1}^{N} I(p_{jt} - w^a_{ijt} > c_i),$$

where $I(\cdot)$ is the indicator function. This equation shows that the number of stocks sold corresponds exactly to those in the investor's portfolio for which $p_{jt} - w^a_{ijt} > c_i$. Intuitively, the number of trades made by an investor is a useful proxy for understanding an investor's transaction costs, since the more sales an investor makes, the more likely it is that this investor tends to have gaps between the market price and the agent's WTA that exceed the cost of selling. Similarly, suppose the investor considers buying N_b stocks. The number of purchase transactions is:

$$N_b = \sum_{j=1}^{N} I(w^p_{ijt} > p_{jt} + c_i)$$

Again, the model shows that an investor who buys a lot of stocks is the type who has WTP deviations above the market price that are generally large relative to their transactions costs. Taken together, the model shows that by looking at investors who trade more, we are narrowing in on the types of investors who are on average likelier to have lower costs of trading c. Therefore, if investor-specific transactions costs explain the winner-loser divergence in holdings, we would expect the divergence to approach zero as we look at sub-samples of higher and higher average trading intensity.[43]

Figure 2a presents separate estimates of the divergence in holding rates of the lottery winners and losers at the end of the first full month after listing, conditional on making a given number of trades per month, on average, in the six months prior to the lottery. The x-axis represents bins of increasingly higher numbers of trades, in steps of 2. For example, the black triangle at the zero point on the x-axis shows, for the group of lottery winners who made less than two trades per month on average in the six

[43] Another way to evaluate the investor based transaction cost story is to consider one simple way that investors could eliminate this anomalous behavior: lottery winners could always sell the stock after listing. Is it plausible that lottery winners who hold the stock are a particularly high transaction cost group, and this is what explains why they do not sell sooner? This does not appear to be the case in the full sample, as 75.2 percent of lottery winners who sold in the first month also made a transaction of equal or lesser value than the IPO allotment; similarly, 74 percent of lottery winners who did not sell made the same size transaction. Comparing these groups in a regression with IPO share category fixed effects, we find that lottery winners who sold the IPO stock are 2.1 percentage points *less* likely to have made another small transaction.

months prior to the lottery, the fraction that hold the IPO stock at the end of the first full month after listing. Similarly, the green circle corresponds to the fraction of lottery losers with the same pre-IPO average trading intensity who held the IPO stock at the end of the same month. The black triangle and green circle at the 20 marker on the x-axis are the corresponding fractions for investors who made between 20 and 22 trades per month on average in the six months prior to the IPO. The bars indicate 95 percent confidence intervals.[44] The last estimates at the right-end of the x-axis include investors that made more than 29 trades per month on average in the six months prior to the IPO. (98.4 percent of the sample made less than 32 trades on average per month, so the points shown in this figure cover the vast majority of our data.) The figure shows that as we look at sub-samples who have traded larger amounts, there is some convergence, but there is little suggestion that the effect goes to zero for even the most frequent traders in the sample.[45] It is also interesting to note that the slope of this curve is essentially flat beyond the five trades per month mark, suggesting little relationship between trading propensity and the divergence in winner-loser behavior once we move beyond a relatively low trading propensity threshold.

Figure 3a plots the experiment by experiment winner-loser ownership divergences (in the same fashion as Figure 1) estimated for a group of 54,678 investors (treatment: 16,545, control: 38,133) who made an average of 20 trades per month in the 6 months prior to the random allotment. Figure 3a(ii) shows that heavy-trading lottery losers in IPOs with realized returns through the end of the first month do appear substantially more likely to buy the IPO stock than lottery losers in the full sample, consistent with our motivation for looking at this sub-sample. Overall, however the figures still show a clear divergence in the holding behavior of lottery winners and losers.

Case 3: Investor-Time Specific Transaction Costs. Next, suppose $c = c_{it}$, so that the costs of trading are investor-time specific. For example, there may be months where the investor is busy at work, and c_{it} is correspondingly high, but in other months, she has more time to focus on her stock portfolio. To analyze the importance of this form of transactions costs, we focus on the sub-sample of investors i

[44]We use the approximation presented in Cochran (1977) to estimate the standard errors of the weighted means.

[45]In general, we find that portfolio turnover, as measured by the number of trades the investor does relative to the number of positions held, increases as the number of trades increases, so these results can also be interpreted as separate estimates by amount of turnover.

at each time t who tended to have $p_{jt} - w^a_{ijt} > c_{it}$ for stocks they own, and $w^p_{ijt} > p_{jt} + c_i$ for stocks that they considered purchasing. Our approach is to identify this sample by inspecting the behavior of lottery winners and losers who have high trading intensity *in the specific month* in which we estimate the winner-loser divergence in holdings of the IPO stock.

Figure 2b estimates the divergence in holdings between lottery winners and losers, based on the exact number of trades made in the first full month after the IPO lottery.[46] Similar to Figure 2a, we find that the gap between winner and loser holding rates does decline as we focus on applicants who traded more in the first month, but there is again little suggestion that this divergence is limited to those who make a small number of trades.[47] This result is useful in evaluating the potential for transaction costs related to attention to explain the winner-loser divergence. The investors at the right side of this figure are paying attention to their portfolio enough to make almost one trade per day on average in the month of the IPO allotment, so it seems difficult to argue that the cost of paying attention alone could generate such a large winner-loser divergence in the IPO stock. Figure 3b plots the experiment by experiment winner-loser ownership rates estimated for a group of 85,358 investors who made 20 or more trades in the month following random allotment (treatment: 27,216, control: 58,142). Again, the lottery losers in these figures do appear substantially more likely to purchase the IPO stock relative to the full sample, but the average divergence between winners and losers is clear in the raw comparison of winner and loser mean holdings.[48]

Case 4: Investor-Time-Security Specific Transaction Costs. The final possibility that we consider is that the costs of trading are specific to investors at particular times and pertain to particular types of positions within their portfolios. For example, some investors might find that the costs of initiating a trade in the small position in the IPO security are too high to warrant action. To consider this possibility, we condition on a set of investors who recently traded in sizes less than or equal to the

[46]For example, the black triangle (green circle) at the 20 mark on the x-axis is the fraction of winners (losers) who held the stock and made exactly 20 trades in non-IPO stocks in the first full month after listing. This figure covers over 98 percent of the sample.

[47]The number of trades made in the first full month after the IPO are potentially affected by whether the applicant wins the lottery. Anagol et. al. (2015) finds that lottery winners are slightly more likely to trade in the month after listing, but the economic magnitude of these effects are very small.

[48]Appendix Table A.1.5 estimates the divergence by trading intensity over the first six months after listing, and finds the pattern of decline is similar to the full sample.

size of the IPO allotment.[49]

Figure 2c separately estimates the divergences for applicants who made the number of trades (specified on the x-axis) of sizes less than or equal to the size of the IPO allotment. Again, we find the divergence reduces as we look at more active investors, but remains economically and statistically significant for even the most active investors. Figure 3c plots the winner loser ownership divergences estimated for the group of 36,467 investors who made at least 20 trades of sizes less than or equal to the size of the IPO allotment amount in the month following random allotment (treatment: 13,235, control: 23,232). Again, we find lottery losers appear more likely to purchase the stock in more active samples, but the divergences in the raw data continue to be clear.[50]

To investigate the importance of investor-time-security transactions costs, we can also focus even further on sub-samples that sold, in the month of analysis, another IPO allotment. In Appendix Table A.1.7 we estimate the divergence for the sub-sample of investors who were allotted at least one other IPO in the past six months prior to the current IPO, and chose to sell at least one of these previously allotted IPO stocks in the month where we estimate the divergence. For example, in Column (2) of this table, 21,113 investors in the sample actively sold another IPO allotment that they received in the past six months. The divergence in holdings between the lottery winners and losers in this sub-sample remains large and statistically significant.[51] It seems difficult to argue that transactions costs for selling IPO stocks are high for this sub-sample, as we explicitly condition on having sold an allotted IPO stock. It also seems difficult to argue that these investors never actively thought about selling their IPO stock, as they actively sell another IPO stock in exactly the same month.

Active Purchase of Additional IPO Stock. Another type of analysis that is helpful in distinguishing the inertia due to transactions costs model from the endowment effect explanation is to focus on future active choices regarding the IPO stock itself. In Table 4 we test whether lottery winners are more

[49]For example, suppose IPO A allotted lottery winners 150 dollars worth of shares. In this case, we check the prevalence of winner-loser divergences only for those investors who made at least one purchase of size (in a non-IPO stock) less than 150 dollars, made at least one sale less than 150 dollars, or met both these criteria in the month following the random allotment.

[50]Appendix Tables A.1.6 shows these divergences over the first six months for investors who made at least one trade in a position less than the IPO allotment value. The pattern of decline is similar to that in the full sample.

[51]The fact that these differences are smaller may also reflect that this sub-sample has a smaller endowment effect, as naturally those who sell IPO allotments as winners are the types who have lower endowment effects.

likely to purchase the IPO stock on the open market after it lists, compared to the propensity of lottery losers to do so. Panel A shows results for the full sample. In the month of listing, we find that lottery winners are 0.6 percentage points more likely to purchase the stock on the open market than lottery losers are to purchase the stock at all. The size of this effect declines in the months after listing, although even six months after listing, the probability that lottery winners purchase the IPO stock again is twice that of lottery losers, significant at the 1 percent level. When we look at sub-samples that we expect to have lower transactions costs (as discussed above), this effect is even larger, with lottery winners being approximately three percentage points more likely to buy the IPO stock than lottery losers in the listing month, regardless of the measure used.[52] It is difficult to see how a pure transactions costs based inertia story would produce lottery winners who want to actively buy the stock more on the open market than lottery losers, given that under the transactions cost explanation the randomization induces equal WTP/WTA distributions and transactions costs across the groups. In contrast, the endowment effect explanation offers a natural explanation for this: randomly owning the stock raises the average willingness to pay for the stock. In related work we also find that lottery winners are more likely to trade non-IPO stocks in their portfolio than lottery losers, suggesting that, if anything, winning the lottery reduces the transactions costs associated with making a trade (Anagol et al., 2015). This result also goes against the idea that inertia induced by transactions costs is responsible for our results.

Overall, we conclude that these results do not support a model in which costs associated with initiating a transaction are the principal driver of the effects that we detect.

Wealth Effects and Taxes. We consider the extent to which wealth effects, disincentives for flipping (i.e., investors might believe they will be penalized in future IPOs if they flip the stock), and tax motivated behavior are possible explanations for our estimated endowment effects.[53] Regarding wealth effects, the key consideration is that the 62 U.S.D wealth gain lottery winners obtain over losers is very small relative to 1,750 U.S.D all lottery applicants had to put in escrow to participate in the lot-

[52]This is an approximately 40 percent higher proportion of buying the IPO stock relative to the 7 to 8 percent of lottery losers that purchase the IPO stock in these active trading samples.

[53]Our discussion of wealth effects also includes the possibility of a "house money effect" explaining our results, as both are unlikely to explain our results for similar reasons. See appendix for details.

tery in the first place; this small gain is unlikely to be relieving a major wealth constraint for winners relative to losers, as we know both groups have substantial cash on hand in their escrow accounts. Overall, we find little evidence to suggest these explanations play an important role. We provide the results of specific tests of each of these additional explanations in Appendix A.6.

Simple Substitution Effects. One possibility is that investors who lose the IPO lottery decide to buy a substitute stock that takes the place of the IPO stock that they lost in the lottery. This behavior could potentially generate a winner-loser ownership divergence without any shift in valuations; lottery winners would tend to hold the IPO stock because winning that IPO satisfied their demand, and lottery losers would own a different stock with potentially similar characteristics.

Contrary to this hypothesis, however, we find that at the end of the month after the IPO stock lists, the lottery winners hold almost exactly one additional stock relative to the lottery losers. This means that lottery losers are not buying different stocks to close the gap in the number stocks of held (Appendix Figure E.4). Moving forward in time in Appendix Figure E.4, we also see that the trends in the lottery winner and loser groups are almost exactly parallel, once again suggesting that the lottery losers do not make differential purchases in substitute shares. Finally in Anagol et al. (2015) we find that lottery winners are actually 5 to 7 percentage points more likely to buy non-IPO stocks than lottery losers. If lottery losers substituted their lottery loss with other shares, we should observe lottery *losers* being more likely to buy non-IPO stocks in the future.

Multiple Applications Per Household. As discussed earlier, households may have an incentive to submit multiple applications through different brokerage accounts to increase their probability of winning. Could this behavior explain the endowment effect? First, it is not obvious that submitting multiple applications is a good strategy as only about one-third of IPOs end up being over-subscribed enough to initiate the lottery procedure. By submitting multiple applications with the intention of only holding the ones that are allocated, households would take on the substantial risk of their applications being fully allotted. Note also that this behavior would have to be common in almost every IPO share category in our dataset, as the endowment effect on the listing day is large in almost all share categories (See Figure 1a and 1b), and since some of these share categories had quite large probabilities of allotment (see Table 2). Nevertheless, we explore this possibility further in the appendix, and find other features of this explanation appear strongly inconsistent with our results.[54]

The Relationship Between the Endowment Effect and Experience. List (2003) and List (2011) document substantial reductions in the endowment effect when measured for more experienced market participants, raising the possibility that WTA/WTP divergences are simply an artefact of a lack of market experience.

We therefore document how differential holding patterns in the IPO stock vary with plausible proxies of investors' experience in the IPO market. To do so, we interact our main Winner variable in equation 1 with a set of predetermined variables that we believe are interesting proxies for the amount of experience in the IPO market, in a descriptive analysis similar to that in List (2003). Table 5 presents the results of this exercise for the full sample of winner and loser investors, as well as for the samples of "non-inertial" investors before.

Column (1) in Table 5 takes equation (1), and adds a set of interactions between the Winner dummy and dummy variables based on tercile or quartile breakpoints of proxies of investors' experience, listed in the rows. Columns (2), (3), and (4) conduct the same regression, but for the smaller samples of investors in cases 2, 3, and 4 in our discussion of inertia (corresponding, respectively, to c_i, c_{it}, c_{ijt}). Our discussion below mainly focuses on Column (1), but we note here that estimated coefficients are very similarly signed across all proxies of experiences in the four samples, with some differences arising in statistical significance on account of large reductions in sample size.

The first set of rows shows that the estimated endowment effect is highly correlated with the number of IPOs that the winner had been allotted in the past. Accounts which received over 8 (random and nonrandom) allotments in the past have estimated endowment effects that are 17 percentage points smaller than investors with no past IPO experience. However, relative to the base rate listed in the very first row (77.9 percent), even such "experienced" IPO allottees are 60 percent more likely to hold the IPO stock at the end of the first month.

Similarly, the next set of rows show that experience measured by trading activity also reduces the observed endowment effect. Winners with more than 6 trades in the month before IPO allotment are

[54]For example, because the randomization is orthogonal to households' application behavior, this explanation would predict there should be a large amount of buying amongst households where all of the accounts were not allocated – we do not observe this in the data.

14.3 percent less likely to hold the IPO stock compared to those with no past trades. Moreover, high numbers of trades are also associated with greater buying activity by lottery losers.

We then measure past return experience by constructing the fraction of *realized* returns in the preceding six months to the IPO allotment that is greater than the listing return observed in the IPO. We find that if the IPO returns are substantially greater than most previously experienced returns, the endowment effect reduces considerably. Interestingly, the reverse seems to be true for the control group – they appear to have a higher propensity to hold IPOs which have higher listing returns than most they have ever experienced, and vice versa. These effects appear to become far stronger for the group of "non-inertial" investors in columns (2), (3), and (4), especially when explaining winners' propensities to trade the IPO stock. [55] Figure 1 (c) suggests that some version of the disposition effect may be in operation for lottery winners, and this finding on the role of the past return experiences of lottery winners and losers in explaining their propensity to hold or buy suggests an intriguing link between the observed disposition effect and personal experience.

In Appendix Section A.4, we use the randomized allocation of recent lotteries to test whether recent experiences with winning an IPO lottery lower the estimated divergence in holdings generated by subsequent random allotments. We find that recent lottery winners show smaller divergences in holdings, but that these differences are slight. Overall, these results suggest that there is a correlation between measures of investor experience and smaller endowment effects, consistent with the findings in List (2003).[56] However, having experienced many allotments in the past does not appear to lead to quick and complete elimination of the endowment anomaly in this setting.

4 Explanations that Generate WTA-WTP Gaps

In the previous Section, we focused on explanations for our results where lottery winners and losers have identical distributions of valuations for the IPO stock following the lottery, none of which seem completely able to explain our results. In this section, we therefore consider a series of prominent

[55] Appendix A.1.8 presents this analysis at the end of the first full month after listing and is consistent with the analysis on the first-day.

[56] In Appendix Table A.1.3. we present a comparison of the effect sizes in our natural experiment to previously run field and lab exchange experiments. For low experience samples are results are similar, but for high experience samples we find substantially higher endowment effects.

theoretical explanations of endowment effects which involve WTA/WTP gaps as a result of the fact of ownership. We aim 1) to determine the extent to which these models can generate a WTA-WTP gap when set up and solved in environments approximating our real-world setting, and 2) to derive additional testable predictions to see whether they hold up in the data.

1. Expectations as Reference Points – Constant Prices: Kőszegi and Rabin (2006) present a theory where recently formed expectations about future outcomes determine an agent's reference points. In the case of exchange experiments, one simple prediction is that subjects might *expect* to not have the opportunity to trade the endowed good, and so ownership of the good is the relevant recently-formed reference point. Relative to this reference point, the option of trading the good away is encoded as a loss, and subjects thus tend to hold endowed objects more than would be predicted by standard expected utility preferences. In our stock market setting, however, investors almost surely enter the lottery assuming that the stock price will vary in the aftermarket, meaning that models of reference points geared towards lotteries are likely to be more realistic characterizations of our setting.

An additional issue here is that investors in our setting very likely also enter the lottery with the expectation that they will be able to trade the stock after it is listed, given that these stocks are traded on the exchange daily. The idea that winners tend to hold the stock because they expect to own the stock in the future, discounting heavily that they will have the option to trade, is less plausible. This also means that the endowment effect cannot be a preferred personal equilibrium (PPE) when applying this model in our setting.[57] Our results suggest, at a minimum, that endowment effects are possible in markets outside the lab even when agents fully expect to have the opportunity to trade the endowed objects in the future.

2. Expectations as Reference Points – Expected Distribution of Prices. Within the Kőszegi and Rabin (2006) framework, an alternative potential reference point agents might have is ownership of the stock evaluated using the *expected distribution of future prices* of the IPO stock, rather than a constant future price. Interestingly, the expectations based reference point theory of Kőszegi and Rabin (2006) predicts an "endowment effect for risk." Decision makers will be less risk-averse when

[57] For more details see the Appendix, where we present a formal model of a reference point based on expectations with constant prices based on Ericson and Fuster (2014). For recent empirical tests of the expectations as reference points theory of endowment effects see Ericson and Fuster (2014); Goette et al. (2014); Heffetz and List (2014).

the reference point is stochastic and they face the choice of a constant alternative, and more risk averse when the reference point is fixed and they face the choice of a stochastic alternative. The fact that lottery winners take greater risk by continuing to hold the IPO stock, while lottery losers choose not to purchase the IPO stock appears consistent with this prediction of the model, under this formulation of reference points.[58]

In the appendix we present a model where lottery participants have expectations based stochastic reference points. In the model, reference points are determined by expectations, which in turn are determined by the lottery participant's plan of action (which is chosen prior to the stock listing). Lottery losers consider two possible plans; one where they do not buy the IPO stock after it lists, and one where they do buy the stock. Similarly, lottery winners consider a plan to sell the stock versus a plan to hold the stock. We derive the conditions necessary for an endowment effect to appear: the same agent should want to stick to the plan of holding the stock if they win the lottery, but simultaneously want to stick to the plan of not holding the stock if they lose the lottery.

We find that that there is a range of parameters regarding the future success of the stock for which the "endowment effect plan" to hold the stock if the agent wins and not buy the stock if the agent loses the lottery is a personal equilibrium (PE) in the language of Kőszegi and Rabin (2006). The main intuition for this result is the same as in Sprenger (2015); agents demonstrate an "endowment effect for risk" – they exhibit lower risk aversion when endowed with a gamble and consider trading it for cash, than when they are endowed with cash and consider trading it for a gamble.

The range of parameters that can deliver the result control the beliefs of the agent regarding the future performance of the stock. To provide intuition for this result, these parameters need to deliver a "medium sized" expected return. If the expected return is too high (low), the model predicts that losers will buy the IPO stock (winners will sell), eliminating any endowment effect. In particular, the

[58] Sprenger (2015) and Song (2015) both present laboratory evidence confirming this prediction of the KR theory. Note that neither standard expected utility theory nor disappointment aversion (another leading theory of reference point determination where the reference point is based on the certainty equivalent of a gamble), predict this so called "endowment effect for risk." In addition, previous laboratory research has found that subjects' risk aversion decreases regarding a given lottery depending on whether they are initially endowed with the lottery (see Sprenger (2015) for a detailed summary). For example, Knetsch and Sinden (1984) and Kachelmeier and Shehata (1992) find higher WTA than WTP for gambles, and survey estimates of risk-aversion are sensitive to whether the subject is endowed with the risk and trading for a sure amount or vice-versa (Schoemaker, 1990).

probability of the up state has to be high enough so that the agent sticks to holding the stock when they win, but simultaneously has to be low enough so that the agent also sticks to holding cash if they lose the lottery. Our model in the appendix assumes that the stock can go up or down a fixed amount with probability q and $1-q$, and that the gain and loss on the stock are proportional, with factor of proportionality k (gains are k times losses on the stock). Given this setup, medium size expected returns can either be delivered by expectations of low probabilities of relatively high gains, or high probabilities of low gains. That is, the agent will demonstrate an endowment effect for a wide range of q values, but k must be negatively correlated with q for the endowment effect to hold.[59,60]

3. Expectations as Reference Points – Model Including Lottery and the IPO After Market. The reference dependent models presented so far abstracts away from the fact that the random assignment in our empirical setting occurs in lotteries with different probabilities of winning, and in IPOs with different listing gains. In Appendix B, we present a model of an agent with expectations based reference dependent preferences who has chosen to enter the lottery for an IPO stock, experiences a listing gain, and decides on a plan of action based on whether or not she wins the lottery, as well as on how the stock performs in the aftermarket. This model is a more realistic characterization of our empirical setting.[61] This model delivers similar predictions to the model that we describe above, about the negative relationship between k and q required to deliver an endowment effect. Another prediction of the model is that the range of values in which an endowment effect holds decreases as p, the probability of winning the lottery, increases. The intuition for this result is that as p approaches 1 in this model, the comparisons agents make across winning and losing the lottery become less and less important, because it is unlikely that they will lose the lottery. As the comparison across winning and losing becomes less important, decision making depends more and more on the expected return of the stock, which pushes agents towards either always selling the stock if the expected return is low,

[59] For example, if $0.2 < q < 0.4$, depending on the extent of loss aversion, $k = 2.6$ delivers an endowment effect, but if $0.8 < q < 1$, k must be 0.2 to see an endowment effect.

[60] The PE condition satisfied by these parameter values only guarantees that the agent does not wish to deviate from the endowment effect plan. However, it does not guarantee that pursuing this plan delivers the agent the highest expected utility of all possible plans. When we derive these conditions (for a "preferred personal equilibrium" or PPE (Kőszegi and Rabin (2006))), as in Sprenger (2015), we confirm that there is no endowment effect for risk. See the Appendix for more details on why the endowment effect plan is not a PPE in our setting.

[61] We refer the reader to Appendix B for the details of the model, but focus on presenting the basic setup and the intuition for our results in the paper.

or always purchasing if the expected return is high. This result has some support in the data – looking at our empirical estimates of how the endowment effect varies with the probability of winning a given lottery in Table 5, we find that when p goes from zero to 1, we find that the estimated endowment effect also falls, from 0.73 to 0.59.

4. Aversion to Bad Deals. A candidate explanation for endowment effects in general (including those in our setting) is that lottery losers have an "aversion to bad deals" as described in Weaver and Frederick (2012); in particular, lottery losers might see purchasing the stock after the IPO as a bad deal because the stock typically trades higher than the issue price even though the issue price is irrelevant for the future performance of the stock. We formally apply the model of Weaver and Frederick (2012) to our setting in the appendix, but summarize the main results of the model here.

The model can generate an endowment effect because lottery losers' valuations of the stock are distorted downwards due to their disutility from having to pay a price higher than the issue price. However, this distortion does not occur for lottery winners because they already own the stock, and therefore do not have to transact at the listing price to add it to their portfolio. In addition to predicting an endowment effect, the model also predicts that the endowment effect should get smaller as the listing gain gets smaller. The intuition for this result is that as the listing gain gets smaller, lottery losers have the opportunity to buy the stock at a price closer and closer to the price that lottery winners paid. The motivation for lottery losers to feel like they are getting a "bad deal" when they purchase the stock in the aftermarket therefore declines as the listing gain decreases.

We find mixed evidence on this prediction. On the day of listing, we find in the full sample (Figure 1 Panels (a) and (b)) as well as in highly active trading samples (Figure 2, (i) figures), that there is little evidence of a relationship between the size of the listing gain and the endowment effect. However, when we look at the end of the first full month of trading, the tendency of lottery losers to hold the stock does decline as the absolute value of the return on the IPO stock increases. These results suggest that at least part of the reason an endowment effect exists in this setting is that lottery winners' and losers' valuations for the stock are influenced by different reference prices.

An additional prediction of this model is that as the IPO stock price approaches the issue price over time, we should see the endowment effect go down as lottery losers become more willing to purchase the stock (assuming the reference price remains the issue price over time). In Table 4, we find that by the end of the second month after the IPO, the mean return on the IPO stocks in our sample is minus one percent relative to the issue price. Thus, if the main reason lottery losers choose not to purchase the IPO stock is because of an aversion to paying a price higher than the issue price, we should see much more buying three months after the IPO (on average). The data shows, however, that only 1.5 percent of lottery losers choose to own the IPO stock even when it has essentially returned back to the issue price, which is inconsistent with the sole explanation for the endowment effect being based on losers feeling that they are engaging in ”bad deals” relative to the issue price.

A previous version of this paper included a simple version of a realization utility based model with loss aversion. In that model the endowment effect resulted because lottery winners had a potential realization utility gain due to the listing gain, while lottery losers did not. On the margin, this made lottery winners more willing to hold the IPO stock than lottery losers. This model made the same prediction as the Aversion to Bad Deals model, in that the winner-loser divergence in holdings should increase as we look at larger and larger listing gains. It is also worth noting that a more sophisticated version of the realization utility model with either diminishing sensitivity or time discounting, as in Barberis and Xiong (2012) and Ingersoll and Jin (2013) would yield a disposition effect for winners, i.e., that the selling propensity would increase in the strength of holding period returns.

5. **Information Acquisition Costs and Incentives.** Van Nieuwerburgh and Veldkamp (2010) present a model where investors' decisions to learn about assets are jointly determined with their choices to hold those assets. In particular, the mechanism in their model is that investors choose to invest in information about securities they *expect* to hold; once they have acquired information about the stock it becomes optimal to hold more of the stock, and then once they hold more of the stock it is optimal to invest more in learning about it because a given information signal is more valuable if the investor owns more shares.

In our setting, both lottery winners and losers should have the same expectations of holding the stock before the randomized allotment is made, so their incentives to learn about the stock should be the same before the allotment is made. Therefore, at the time of allotment, winners and losers should be balanced in the amount of information they have about the IPO stock. However, once winners are endowed with the stock, the model predicts that their incentive to acquire additional information about the IPO stock should be higher, which might be an explanation for the divergence that we observe. In particular, this additional incentive to do research on the stock could raise lottery winners' WTA above the level of lottery losers' WTP.

One important feature of our results runs contrary to this explanation for our observed endowment effect. Lottery winners continue to hold the IPO stock even though it produces negative 33 percent returns on average, 6 months after issuance, and negative 62 percent, 24 months after issuance. In other words, if lottery winners are acquiring more information about the IPO stock, they appear to be acquiring particularly poor quality information that is causing them to hold an underperforming asset.

6. Sour Grapes. In general, the idea of "sour grapes" is that agents will endogenously lower their valuation of a good they desire if external forces make that good unattainable; in our setting, lottery losers might lower their willingness to pay for the IPO lottery stock because it is not allocated to them in the lottery.[62] Note that, for this explanation, we have to assume that the sour grapes effect does not go away once the stock starts trading, because obviously the IPO stock is no longer unattainable once it is traded on the market. Other related mechanisms that fall under this category would be cognitive dissonance factors that cause losers to lower their valuations, or any other general feature of losing the lottery that makes lottery losers value the stock less.

One way to evaluate the sour grapes hypothesis is to see whether lottery losers are less likely to purchase the IPO stock than they are to purchase a similar stock that they did not randomly lose. Figure 5a plots the probability that the lottery loser purchase the IPO stock in the months following the IPO, as well as the probability that the lottery loser purchases the closest stock in terms of size in the same industry (a "matched" stock). We find that lottery losers are more, not less, likely to purchase the IPO stock than a similar sized stock in the same industry. In Appendix Figure A.1.5 we also find that winners and losers are equally likely to purchase any stock in the same sector, again suggesting that losers are not substituting to another similar stock because they have sour grapes regarding the IPO stock. One weakness with these tests is that it is possible that lottery losers, ex-ante, had a strong

[62]One unappealing feature of this explanation is that there is a related theory, the "forbidden fruit hypothesis," which argues that agents will raise their valuation of items that are unattainable; thus, taken together, the sour grapes and forbidden fruit theories are not falsifiable.

preference for the IPO stock relative to the matched sample or same sector stock, and so the sour grapes motivation reduces their potentially higher demand down to the level of their demand for a similar stock that they did not lose in a lottery.

A second approach to evaluating the sour grapes hypothesis is to test whether lottery losers are less likely to apply to future IPOs, under the (arguably natural) assumption that an investor who loses a lottery develops sour grapes for stocks allocated in IPOs in general. In Anagol et. al. (2015) we find that lottery losers are approximately one percent less likely to apply to future IPOs, but this effect is very small relative to the baseline. For example, 46 percent of lottery losers go on to participate in an IPO in the next month (47 percent of winners do so), again suggesting that losing the lottery is not in general causing lottery losers to feel "sour grapes" for IPO lottery stocks. If sour grapes explain the fact that winners are 30 to 60 percent more likely to hold the IPO stock than losers, it is puzzling that the divergence in future IPO application behavior is so small. This test, however, cannot rule out the possibility that lottery losers develop sour grapes only for the specific IPO stock they lost currently, but do not develop sour grapes for IPO stocks in general.

A third way is to examine the relationship between the estimated divergence between winners' and losers' holdings, and experience in the IPO market. Under the sour grapes explanation, the endowment effect is primarily caused by losers choosing to not purchase the stock. It seems plausible that, under this explanation, IPO lottery participants would learn over time that having "sour grapes" in a situation where the initial allotment is randomized is not sensible. A related argument is that, due to diminishing sensitivity to repeated stimulus, experienced lottery losers would feel the sour grapes less over time. Either way, under the sour grapes explanation the reason we would expect experience to reduce the endowment effect is by causing experienced lottery losers to buy the stock more. However, empirically we find that the endowment effect primarily reduces by more experienced winners being less likely to hold the stock going forward, as opposed to more experienced losers being more likely to buy the stock. In particular, in Table 5, Column (3) we find that a lottery loser who has participated in more than eight IPOs is 1.6 percent more likely to hold the IPO stock (relative to an investor who has never participated in an IPO), whereas a lottery winner who has participated in more than eight IPOs is 8.4 percentage points less likely to hold the stock. We note, however, that this fact does not rule out the possibility that all investors, including more experienced ones, have sour grapes.

7. Winning the Lottery Effect. Winners might feel particularly good about the stock because they won in a lottery and therefore choose to hold it longer than other stocks. One simple way to ascertain the importance of this kind of explanation is to compare the holding behavior of the IPO stock that was won, to stocks the investor *chose* to purchase on their own. We do so by taking the most recent stock an IPO winner purchased on their own, and plotting the probability that they sold this stock in the months after they purchased it. Figure 5(c) plots this alongside the probability that the lottery winner holds the IPO stock that they were allocated. The figure shows that the probability of holding the IPO stock is slightly higher than the recently purchased one, but overall the levels are very similar. This casts doubt on the possibility that winning a stock in a lottery itself has a large impact on future holding behavior.[63]

8. Optimal Expectations. Brunnermeier and Parker (2005) present a theory where agents choose their expectations optimally to trade-off the true expectations with the anticipatory utility that comes from having optimistic beliefs. It seems plausible that, in our setting, lottery winners might get some anticipatory utility from the possibility that the IPO stock will turn out to be a "home-run" investment. These optimistic beliefs would cause lottery winners to hold the stock at greater rates, and could also explain why lottery winners are more likely to actively buy the stock as well. Of course, this theory assumes that agents engage in formulating optimal expectations about an asset that is in their portfolio, but do not form optimal expectations about an asset they are considering purchasing. A more practical concern is that testing this theory would require data on expectations, which are not available in our setting.[64]

[63] It also suggests that our results may have external validity beyond just IPO lottery market (although we cannot test for external validity explicitly).

[64] Optimal expectations is a sub-category of the broader "motivated taste-change" explanation of the endowment effect (Strahilevitz and Loewenstein, 1998; Morewedge, Shu, Gilbert and Wilson, 2009). Under this explanation subjects value an endowed object more because possessions are regarded as an extension of the self, and subjects tend to value objects associated with the self more highly than disassociated objects. Testing this theory would require data on the strength of participants association with the IPO stock, which we naturally cannot measure in our setting.

5 Conclusion

In the absence of wealth effects or transactions costs, standard economic theories predict a fundamental symmetry: the same person should not make different decisions about whether to hold a gamble depending on whether he or she is endowed with the gamble. Data on the behavior of applicants to Indian IPO lotteries refutes this prediction. We find that randomly receiving shares in an IPO increases the probability that an applicant holds these shares for many months after the allotment, and that standard factors such as transaction costs, wealth effects, and taxes are unlikely to explain these effects.

We highlight two broad contributions of our work. First, our results suggest that endowment type effects may have important in-the-field implications for asset markets, in addition to the consumer (mugs, pens) and durable goods (sports cards, collectors pins) markets where they have most commonly been studied. Second, our results lend credence to theoretical frameworks, such as those presented in Thaler (1980), Kőszegi and Rabin (2006), and Bordalo et al. (2012) where an agents' decision process regarding an asset fundamentally changes once the asset enters their portfolio; lottery winners do not have any standard reasons to value the IPO stock more than lottery losers in our setting, but yet continue to hold it at much higher rates. Although our field context does not allow us to definitively determine which variant of these models best explains our evidence, exploring the empirical validity (in other settings) and general equilibrium implications of this type of buyer/seller divergence appears to be a fruitful area for future research.

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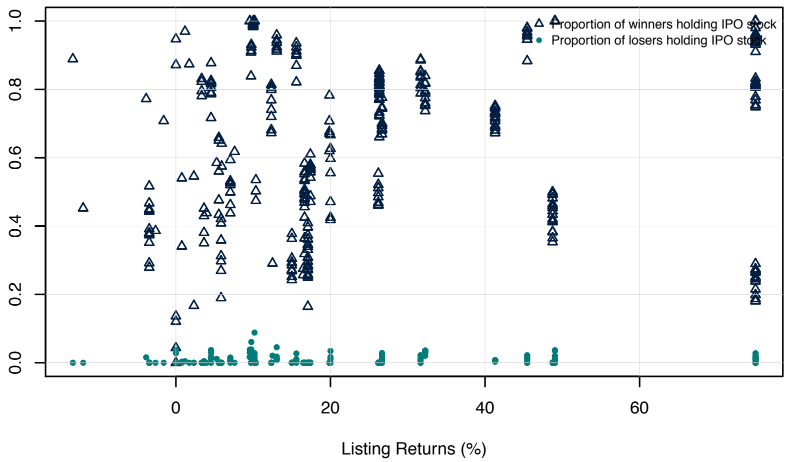
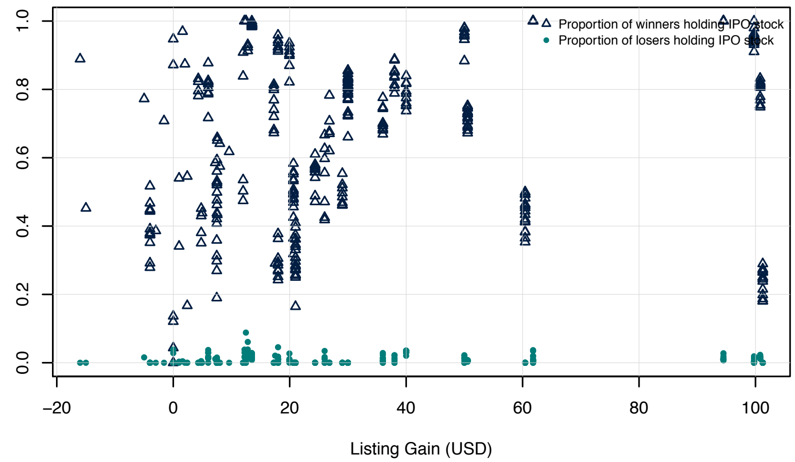
Figure 1: Proportion of Investors Holding IPO Stock and Returns Experience

(a) Listing Returns (%)

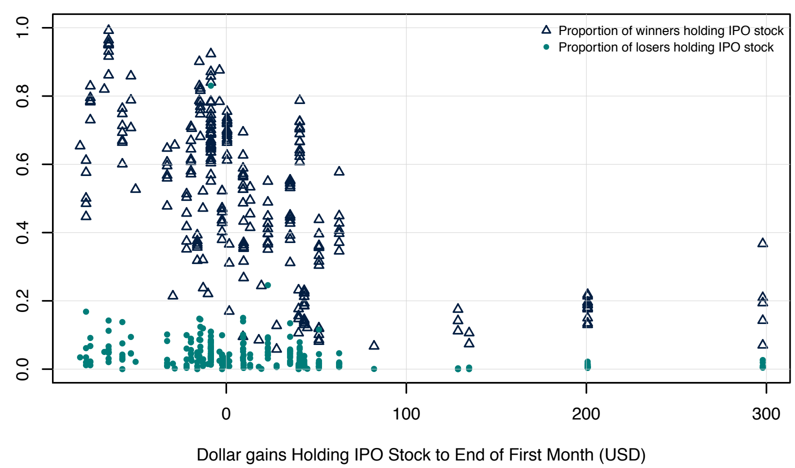


(b) Listing Gain (USD)



(c) Holding Returns at End of First Full Month After Listing (%)

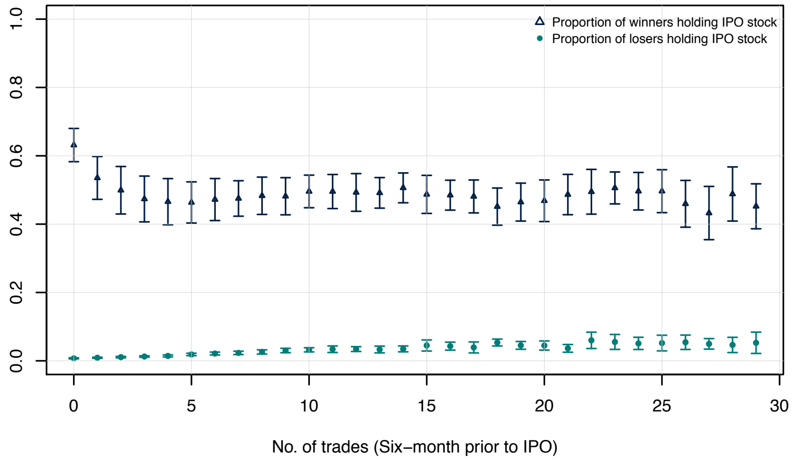
(d) Holding Gain at End of First Full Month After Listing (USD)



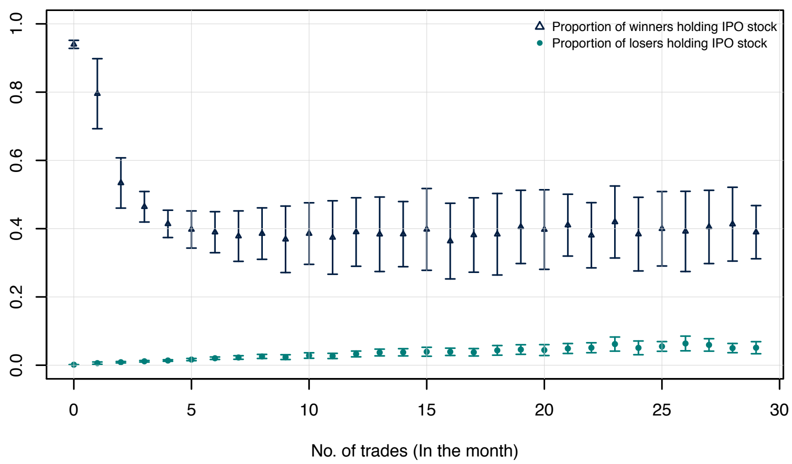
Panels (a) and (b) present estimates at the end of the first day on the y-axis and Panels (c) and (d) present estimates at the end of the first full month on the y-axis.

Figure 2: Winner-Loser Divergence by Trading Activity

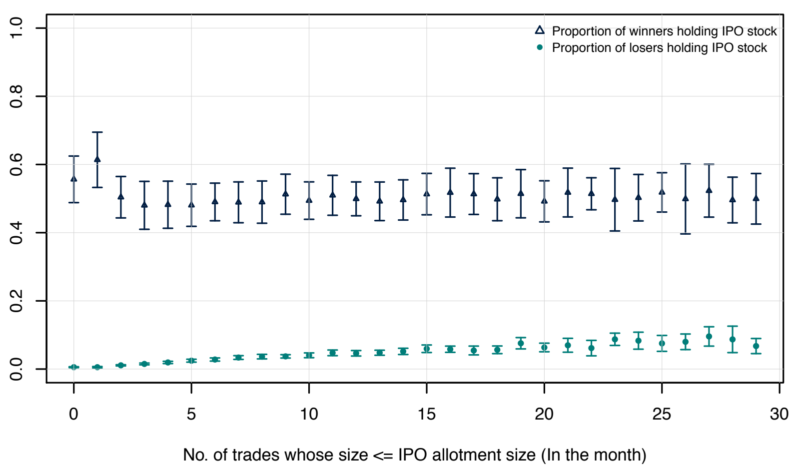
(a) i: By average number of trades per month in six months before IPO allotment



(b) i,t: By number of trades in first full month after listing



(c) i,j,t: By number of trades whose size $\leq$ IPO allotment size in first full month after listing



Note: The 95% confidence interval are constructed using standard errors for weighted mean as in Cochran (1977).

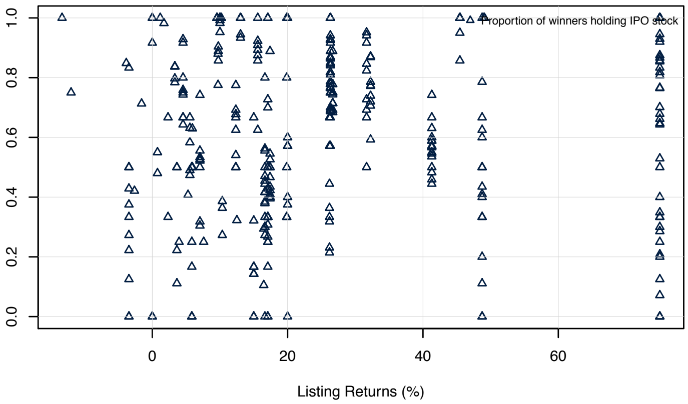
Figure 3: IPO Stock Holding Rates at End of Listing Day Against Listing Returns

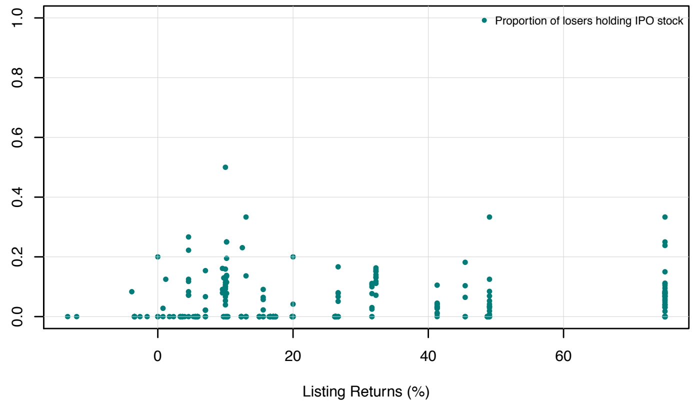
Panel A: Investors with > 20 trades per month on average in six months before lottery

(i) Lottery Winners

(ii) Lottery Losers

Endowment effect estimate: 0.617***



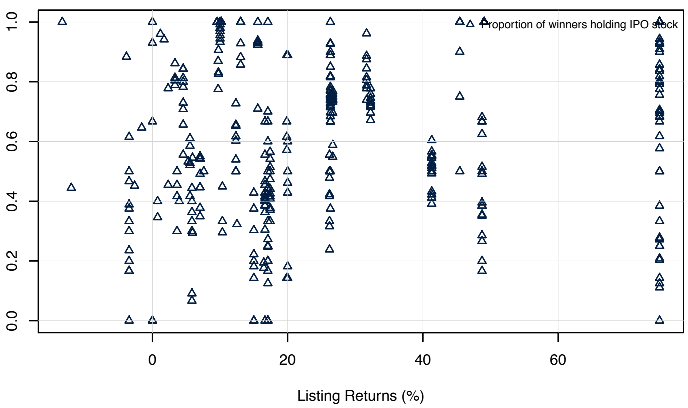


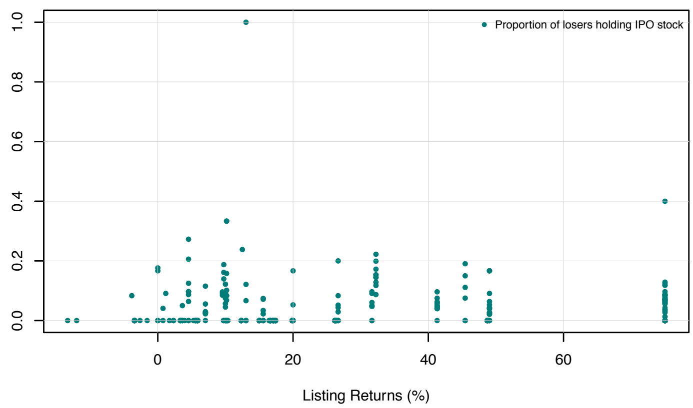
Panel B: Investors with > 20 trades in first full month after allotment

(i) Lottery Winners

(ii) Lottery Losers

Endowment effect estimate: 0.588***



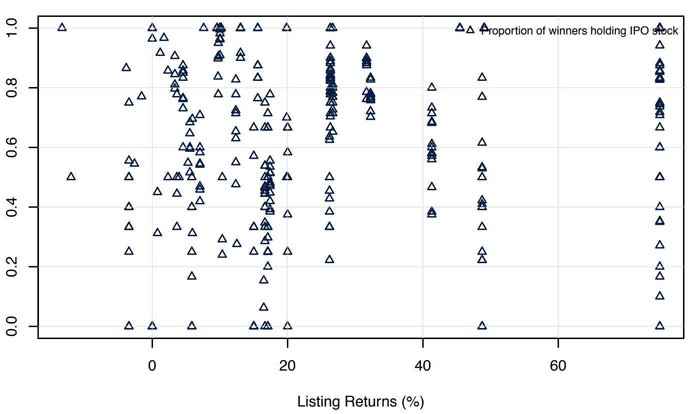


Panel C: Investors with at least 20 trades <= IPO allotment size in first full month after allotment

(i) Lottery Winners

(ii) Lottery Losers

Endowment effect estimate: 0.747***



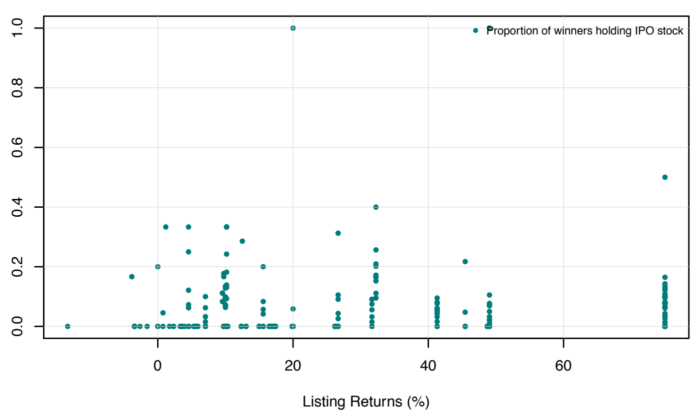


Figure 4: IPO Stock Holding Rates at End of First Full Month After Listing Against Returns

Panel A: Investors with > 20 trades per month on average in six months before lottery

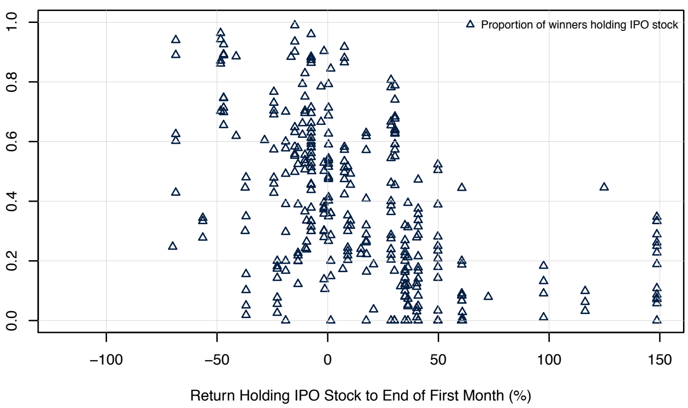
(i) Lottery Winners (ii) Lottery Losers

Endowment effect estimate: 0.427***

Panel B: Investors with > 20 trades in first full month after allotment

(i) Lottery Winners (ii) Lottery Losers

Endowment effect estimate: 0.356***



Panel C: Investors with at least 20 trades <= IPO allotment size in first full month after allotment

(i) Lottery Winners (ii) Lottery Losers

Endowment effect estimate: 0.430***

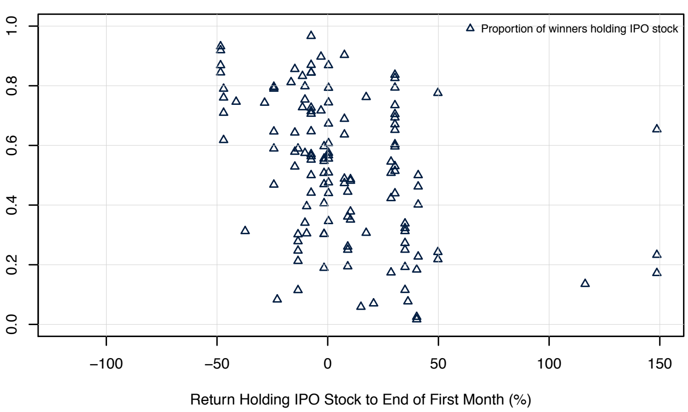
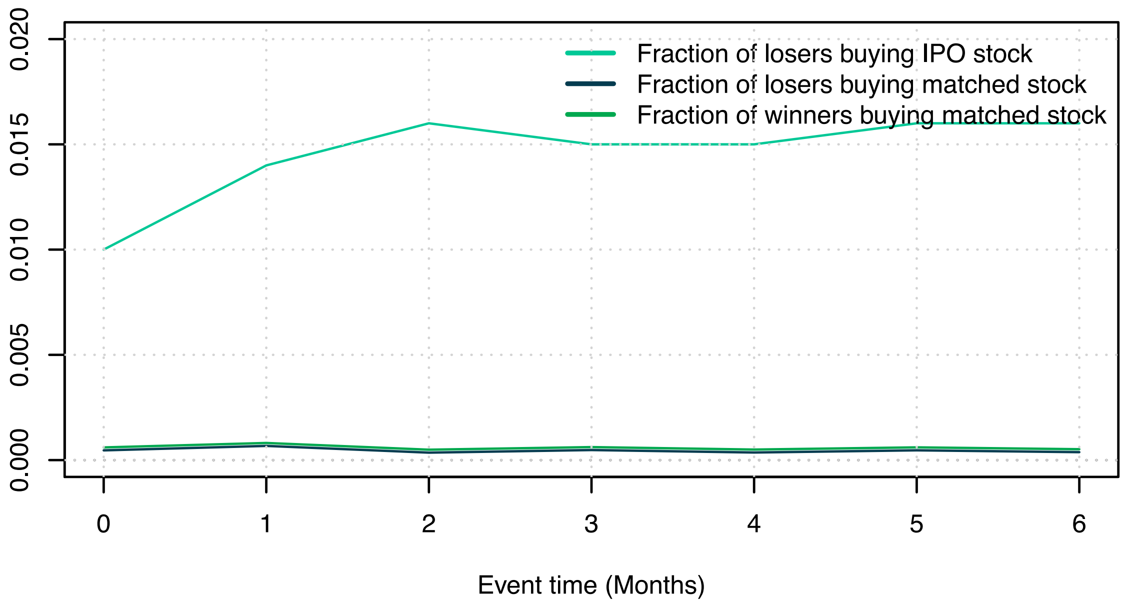


Figure 5: Winners' propensity to hold and losers' propensity to buy

(a) Losers' propensity to buy matched stock



(b) Winners' propensity to hold

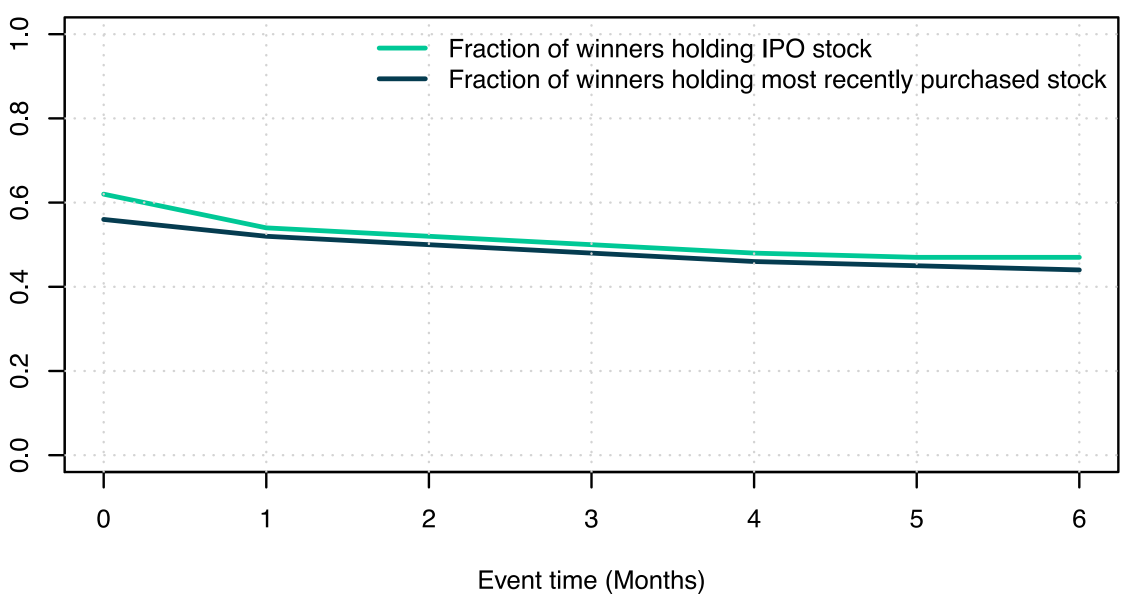


Table 1: RANDOMIZATION CHECK

	Winner Mean (1)	Loser Mean (2)	Difference (3)	% Experiments > 10% significance (4)
Applied/Allotted an IPO	0.379	0.379	0.000	8.97
Cutoff Bid	0.926	0.925	0.001	10.96
Gross No. of Transactions				
No. of Transactions > 0	0.682	0.683	-0.001	9.66
No. of Transactions = 1 to 5	0.449	0.451	-0.002	8.35
No. of Transactions = 6 to 10	0.116	0.115	0.000	11.22
No. of Transactions = 11 to 20	0.070	0.069	0.000	8.87
No. of Transactions > 20	0.048	0.047	0.000	9.92
Gross No. of Transactions ≤ IPO Allotment Value				
No. of Transactions > 0	0.635	0.618	0.017	5.48
No. of Transactions = 1 to 5	0.477	0.483	-0.006	7.83
No. of Transactions = 6 to 10	0.087	0.077	0.011	7.66
No. of Transactions = 11 to 20	0.047	0.041	0.006	23.24
No. of Transactions > 20	0.025	0.019	0.007	34.46
IHS Portfolio Value	6.673	6.667	0.006	13.05
Portfolio Value = 0	0.214	0.215	0.000	10.18
Portfolio Value = 0 to 500$	0.129	0.129	0.000	12.94
Portfolio Value = 500 to 1000$	0.087	0.087	0.000	10.18
Portfolio Value = 1000 to 5000$	0.317	0.317	0.000	8.09
Portfolio Value > 5000$	0.252	0.252	0.000	9.39
Flipper	0.287	0.286	0.001	13.21
No. of Securities Held	9.091	9.013	0.077**	10.96
IHS Account Age	3.148	3.143	0.005*	12.53
New Account	0.055	0.055	0.000	5.74
1 Month old	0.067	0.067	0.000	9.14
2-6 Months old	0.191	0.192	-0.001	8.87
7-13 Months old	0.141	0.141	0.000	8.87
14-25 Months old	0.167	0.167	0.000	9.92
> 25 Months old	0.375	0.373	0.002**	12.01

N = 1,561,497. All variables are measured one month prior to the lottery allotment. *,**,*** denote significance at the 10, 5 and 1 percent levels. The flipper dummy takes the value 1 if the account had ever received an IPO and sold it in the month of receiving it.

Table 2: CHARACTERIZING LOTTERY APPLICATION AND ALLOTMENT EXPERIENCE

Treatment Characteristics	Mean (1)	Percentile Across Experiments: 10 (2)	20 (3)	50 (4)	75 (5)	90 (6)
Application Amount ($)	1,750	155	343	791	1,397	2,093
Probability of Treatment	0.36	0.09	0.20	0.37	0.64	0.84
Allotment Value ($)	150	125	130	142	158	169
First Day Gain/Loss (%)	39.18	-7.57	6.10	17.13	37.08	87.77
First Day Gain/Loss ($)	61.89	-11.14	8.49	24.78	53.03	136.94
Median Portfolio Value (t-2,$)	1,748	722	1,088	1,594	2,270	2,999

Table 3: EFFECT OF WINNING IPO LOTTERY ON OWNERSHIP OF IPO STOCK

		Listing	Months Since Listing						
Dependent Variable:		Day	0	1	2	3	4	5	6
I(Holds IPO Stock)	$\bar{y_w}$	0.700	0.624	0.542	0.519	0.497	0.484	0.474	0.466
	$\bar{y_l}$	0.007	0.010	0.014	0.016	0.015	0.015	0.016	0.016
	ρ	0.693***	0.613***	0.527***	0.503***	0.482***	0.468***	0.458***	0.449***
Fraction of Allotment	$\bar{y_w}$		0.645	0.576	0.562	0.543	0.533	0.529	0.522
	$\bar{y_l}$		0.044	0.058	0.061	0.061	0.064	0.065	0.065
	ρ		0.601***	0.518***	0.501***	0.481***	0.470***	0.464***	0.457***
I(Holds Exactly IPO Allotment)	$\bar{y_w}$		0.587	0.501	0.477	0.456	0.442	0.432	0.423
	$\bar{y_l}$		0.001	0.002	0.002	0.002	0.002	0.002	0.002
	ρ		0.586***	0.499***	0.475***	0.454***	0.440***	0.429***	0.420***
Value of IPO Shares Held (USD)	$\bar{y_w}$		108.818	84.037	72.500	70.226	59.546	53.168	54.717
	$\bar{y_l}$		7.232	8.197	7.767	7.995	7.621	7.004	7.418
	ρ		101.582***	75.835***	64.727***	62.230***	51.927***	46.164***	47.296***
Portfolio Weight of IPO Stock	$\bar{y_w}$		0.133	0.093	0.080	0.077	0.070	0.064	0.064
	$\bar{y_l}$		0.001	0.002	0.002	0.002	0.001	0.001	0.001
	ρ		0.132***	0.091***	0.079***	0.075***	0.069***	0.063***	0.063***
Mean Listing Return		42							
Mean Return Over Issue Price			19	6	- 1	2	- 5	- 6	- 6
Mean Return Over Listing Price			-15	-24	-29	-27	-31	-33	-33
Mean Market Return			2	4	3	1	8	10	9

The sample size is 1,561,497 accounts in each month. *,**,*** denote significance at 10, 5 and 1 percent levels. $\bar{y_w}$ denotes the winner group average, $\bar{y_l}$, the loser group average and ρ the coefficient estimated from equation 1. Market returns are computed over the holding period and obtained from `http://www.iimahd.ernet.in/~iffm/Indian-Fama-French-Momentum/DATA/20160831_FourFactors_and_Market_Returns_Monthly.csv`.

Table 4: PROPENSITY TO BUY ADDITIONAL QUANTITY OF IPO STOCK

		Months Since Listing						
		0	1	2	3	4	5	6
Panel A: Full Sample								
I(Buy IPO Stock)	$\bar{y_w}$	0.0166	0.0098	0.0065	0.0047	0.0038	0.0051	0.0041
	$\bar{y_l}$	0.0110	0.0055	0.0030	0.0021	0.0014	0.0020	0.0017
	ρ	0.0055***	0.0043***	0.0035***	0.0026***	0.0023***	0.0031***	0.0024***
Panel B: Investors $\geq$ Average 20 Trades in Six Months Prior to IPO Allotment								
I(Buy IPO Stock)	$\bar{y_w}$	0.094	0.055	0.035	0.029	0.023	0.027	0.022
	$\bar{y_l}$	0.067	0.037	0.025	0.018	0.013	0.015	0.013
	ρ	0.027***	0.019***	0.011***	0.011***	0.011***	0.012***	0.008***
Panel C: Investors $\geq$ Trades in Current Month								
I(Buy IPO Stock)	$\bar{y_w}$	0.106	0.079	0.064	0.051	0.040	0.051	0.046
	$\bar{y_l}$	0.077	0.064	0.045	0.032	0.026	0.033	0.032
	ρ	0.029***	0.015***	0.019***	0.019***	0.014***	0.018***	0.014***
Panel D: Investors $\geq$ 20 Trades of $\leq$ Size to IPO Allotment								
I(Buy IPO Stock)	$\bar{y_w}$	0.108	0.058	0.039	0.033	0.025	0.031	0.025
	$\bar{y_l}$	0.080	0.039	0.029	0.020	0.014	0.019	0.016
	ρ	0.027***	0.019***	0.010***	0.012***	0.011***	0.013***	0.009***

The sample sizes in panels A,B,C, and D are 1,561,497, 54,678, 85,358, 36,467 respectively. *,**,*** denote significance at 10, 5 and 1 percent levels. $\bar{y_w}$ denotes the winner group average, $\bar{y_l}$, the loser group average and ρ the coefficient estimated from equation 1.

Table 5: HETEROGENEOUS FIRST-DAY WINNER EFFECTS BY PRE-EXISTING ACCOUNT CHARACTERISTICS

Dependent Variable: First Day I(IPO Stock Held)	Full Sample	i (Avg. 6 mnths)	i,t All trades (Month after allotment)	i,j,t (Small trades) (Month after allotment)
Winner	0.779***	0.562***	0.745***	0.782***
# of IPOs Allotted				
1 to 2 IPOs	0.000	-0.002	0.000	-0.002
3 to 8 IPOs	0.003**	-0.005	-0.001	-0.003
$>$ 8 IPOs	0.009***	-0.002	0.009***	0.003
Winner $\times$				
# of IPOs Allotted				
1 to 2 IPOs	-0.052***	-0.048***	-0.027***	-0.036***
3 to 8 IPOs	-0.095***	-0.054***	-0.043***	-0.038***
$>$ 8 IPOs	-0.165***	-0.098***	-0.094***	-0.064***
# of Trades Made				
1 to 2 trades	0.002***	0.000	0.008	0.006
3 to 6 trades	0.001***	0.005	0.018***	0.012
$>$ 6 trades	0.010***	0.011	0.012**	0.032***
Winner $\times$				
# of Trades Made				
1 to 2 trades	-0.031***	-0.140	-0.057***	-0.006
3 to 6 trades	-0.096***	-0.026	-0.153***	-0.072
$>$ 6 trades	-0.143***	-0.122	-0.119***	-0.140***
Fraction Past Returns $>$ Listing Returns				
0.01 to 0.15	0.008***	0.001	-0.002	0.008
0.16 to 0.50	-0.007***	-0.002	-0.009***	-0.008
$>$ 0.50	-0.017***	0.001	-0.027***	-0.026***
Winner $\times$				
Fraction Past Returns $>$ Listing Returns				
0.01 to 0.15	-0.100***	-0.008	-0.018*	-0.076***
0.16 to 0.50	-0.047***	0.060***	0.025**	-0.021
$>$ 0.50	0.018***	0.166***	0.133***	0.080***
Winner $\times$				
Listing Returns (%)				
$<=0$	-0.217***	-0.310***	-0.295***	-0.342***
26 to 41 percent	-0.053***	-0.144***	-0.157***	-0.138***
$>$ 41 percent	-0.056***	-0.015	-0.052***	-0.037***
Winner $\times$				
Probability of Treatment				
33 to 66 percent	0.004*	0.031***	-0.009	0.014
$>$ 66 percent	-0.033***	0.039***	0.032***	0.032***
Controls				
Portfolio Size	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes
IPO Share Category Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R-squared	0.64	0.51	0.48	0.54
Number of observations	1,561,497	54,678	85,358	36,467

Dummies are based on quartile breakpoints of the respective distributions.

Online Appendix to Endowment Effects in the Field: Evidence from India's IPO Lotteries

Santosh Anagol* Vimal Balasubramaniam† Tarun Ramadorai‡

October 28, 2016

Abstract

This online appendix contains two parts, the supplementary empirical appendix and the model appendix. In the model appendix we set up and solve several versions of the Kőszegi and Rabin (2006) expectations based reference dependent utility model, including one which more closely matches the features of the real-world setting that we observe. We also present the Weaver and Frederick (2012) reference price theory of the endowment effect. Throughout, we discuss the features of the empirical results that are consistent and inconsistent with the predictions of these models.

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A Supplementary Empirical Appendix

A.1 Appendix Tables and Figures

Table A.1.1: EXAMPLE IPO ALLOCATION PROCESS: BARAK VALLEY CEMENT IPO ALLOCATION

Share Category	Shares Bid For	# Applications	Total Shares	Proportional Allocation	Win Probability	Shares Allocated	# Treatment group	# Control group
c	cx	a_c	$a_c cx$	$\frac{cx}{v}$	$\frac{c}{v}$		$\frac{c}{v} \times a_c$	$(1 - \frac{c}{v}) \times a_c$
(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	150	14,052	2,107,800	4	0.027	57,000	380	13,672
2	300	9,893	2,967,900	8	0.054	80,250	535	9,358
3	450	5,096	2,293,200	12	0.081	61,950	414	4,682
4	600	4,850	2,910,000	16	0.108	78,750	525	4,325
5	750	2,254	1,690,500	20	0.135	45,750	305	1,949
6	900	1,871	1,663,900	24	0.162	45,450	304	1,567
7	1050	4,806	5,046,300	28	0.189	136,500	910	3,896
8	1200	2,900	3,480,000	32	0.216	94,050	628	2,272
9	1350	481	649,350	36	0.244	17,550	117	364
10	1500	1,302	1,953,000	41	0.271	52,800	352	950
11	1650	266	436,900	45	0.298	11,850	79	187
12	1800	317	570,600	49	0.325	15,450	103	214
13	1950	174	339,300	53	0.352	9,150	61	113
14	2100	356	747,600	57	0.379	20,250	135	221
15	2250	20,004	45,009,000	61	0.406	1,217,700	8119	11,885

Note: Columns (7) and (8) are obtained after applying the regulation defined rounding off methodology as described in paper.

Table A.1.2: IPO CHARACTERISTICS

	2007	2008	2009	2010	2011	All
IPOs in sample						
Number of IPOs in sample	12	10	2	22	8	54
Percentage of all IPOs in India	12.04	31.58	11.76	32.84	20.51	22.13
Value of IPOs in sample ($ bn)	0.28	0.42	0.03	1.58	0.34	2.65
Percentage of total value of IPOs in India	3.00	8.77	0.72	11.01	24.62	7.71
Percentage issued (Retail investors excl. employees)	33.01	34.33	34.88	32.71	35.00	33.50
Over-subscription ratio	21.95	12.63	2.11	10.10	6.72	12.06
No. of randomized share categories (“Experiments”)	109	55	2	177	40	383
Total no. of share categories	178	152	28	398	227	983
No. of IPOs from different sectors						
Technology	1	1	0	2	0	4
Manufacturing	8	6	2	12	3	31
Other Services	2	3	0	8	4	17
Retail	1	0	0	0	1	2

Table A.1.3: Comparison of Endowment Effect Sizes With Previous Studies

Study	Sample	Good A	Good B	Endowment Effect (%)
Panel A: Low Experience Samples				
Current Study	Retail Investors (1st IPO Allotment)	IPO Stock	Cash	77
Current Study	Retail Investors (1 to 2 IPO Allotments)	IPO Stock	Cash	72
List (2003)	Card Show Non-Dealers	Baseball Ticket	Baseball Certificate	60
List (2003)	Pin Show Inexperienced Consumers	Valentine's Pin	St. Patrick Day's Pin	64
List (2003)	Card Show Non-Dealers	Autographed Photo	Autographed Baseball	29
List (2011) September Round	Inexperienced Card Show Attendees	Sports Memorabilia	Sports Memorabilia	73
List (2011) December Round	Inexperienced Card Show Attendees	Sports Memorabilia	Sports Memorabilia	79
List (2011) February Round	Inexperienced Card Show Attendees	Sports Memorabilia	Sports Memorabilia	59
Panel B: High Experience Samples				
Current Study	Retail Investors (3 to 8 IPO Allotments)	IPO Stock	Cash	67
Current Study	Retail Investors (>= 8 IPO Allotments)	IPO Stock	Cash	60
List (2003)	Card Show Dealers	Baseball Ticket	Baseball Certificate	9
List (2003)	Pin Show Experienced Consumers	Valentine's Pin	St. Patrick Day's Pin	7
List (2003)	Card Show Dealers	Autographed Photo	Autographed Baseball	9
List (2011) December Round	Experienced Card Show Attendees	Sports Memorabilia	Sports Memorabilia	31
List (2011) February Round	Experienced Card Show Attendees	Sports Memorabilia	Sports Memorabilia	-10

Table A.1.4: LONG RUN EFFECT OF WINNING IPO LOTTERY ON OWNERSHIP OF IPO STOCK

Dependent Variable:		Months Since Listing 0	1	4	8	11	12	13	16	20	24
I(Holds IPO Stock)	$\bar{y_{tr}}$	0.639	0.571	0.513	0.483	0.465	0.458	0.452	0.434	0.401	0.366
	$\bar{y_{ct}}$	0.012	0.014	0.015	0.016	0.017	0.017	0.017	0.017	0.016	0.015
	ρ	0.628***	0.557***	0.498***	0.467***	0.448***	0.441***	0.434***	0.417***	0.385***	0.350***
Fraction of Allotment	$\bar{y_{tr}}$	0.662	0.600	0.556	0.544	0.532	0.527	0.529	0.510	0.471	0.449
	$\bar{y_{ct}}$	0.039	0.046	0.047	0.056	0.062	0.063	0.065	0.068	0.066	0.075
	ρ	0.623***	0.554***	0.509***	0.488***	0.470***	0.464***	0.463***	0.442***	0.405***	0.374***
I(Holds Exactly IPO Allotment)	$\bar{y_{tr}}$	0.598	0.526	0.467	0.434	0.415	0.409	0.402	0.385	0.356	0.323
	$\bar{y_{ct}}$	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003
	ρ	0.596***	0.524***	0.466***	0.432***	0.413***	0.406***	0.400***	0.383***	0.354***	0.321***
Value of IPO Shares Held (USD)	$\bar{y_{tr}}$	119.187	93.533	57.904	34.810	22.599	20.450	18.281	32.914	33.164	30.496
	$\bar{y_{ct}}$	7.081	7.657	5.570	4.242	3.066	2.827	2.625	4.363	4.555	5.004
	ρ	112.111***	85.876***	52.34***	30.572***	19.536***	17.625***	15.658***	28.552***	28.612***	25.495***
Portfolio Weight of IPO Stock	$\bar{y_{tr}}$	0.136	0.095	0.068	0.055	0.045	0.044	0.040	0.047	0.040	0.034
	$\bar{y_{ct}}$	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	ρ	0.135***	0.093***	0.067***	0.054***	0.044***	0.043***	0.039***	0.046***	0.039***	0.033***
Mean Listing Return		52									
Mean Return Over Issue Price		22	9	-8	-25	-46	-54	-57	-51	-49	-44
Mean Return Over Open Price		-18	-27	-39	-52	-64	-70	-72	-66	-65	-62

The sample includes all IPOs that occurred 24 months before the end of our portfolio data in March 2012. The sample size is 1,090,346 accounts in each month. *,**,*** denote significance at 10,5, and 1 percent levels. $\bar{y_{tr}}$ denotes the treatment group average, $\bar{y_{ct}}$, the control group average and ρ the coefficient estimated from the difference-in-difference specification.

Table A.1.5: ENDOWMENT EFFECT AND NON-IPO SMALL SIZE TRADING INTENSITY

Dep. Var:	Months Since Listing						
Fraction of Allotment Held	0	1	2	3	4	5	6
	Trade size $\leq$ IPO allotment value						
Month before allotment	0.587	0.498	0.480	0.460	0.447	0.442	0.435
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)
In the Month	0.594	0.485	0.435	0.383	0.481	0.461	0.376
	(0.003)	(0.004)	(0.005)	(0.014)	(0.005)	(0.006)	(0.009)
Upto the End of Month	0.594	0.525	0.507	0.475	0.463	0.459	0.451
	(0.003)	(0.003)	(0.003)	(0.007)	(0.007)	(0.007)	(0.007)
	Trades in position size $\leq$ IPO allotment value						
Month before allotment	0.513	0.408	0.394	0.386	0.378	0.376	0.371
	(0.010)	(0.010)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)
In the Month	0.466	0.339	0.325	0.322	0.355	0.341	0.303
	(0.012)	(0.012)	(0.018)	(0.015)	(0.018)	(0.018)	(0.012)
Upto the End of Month	0.466	0.367	0.358	0.347	0.373	0.394	0.390
	(0.012)	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)	(0.008)

The sample includes all those accounts that had *at least* one trade (buy or sell) that is less than or equal to the IPO allotment value. Position size is estimated at the end of the previous month. Rows named “Upto the End of Month” do not include trades before listing month 0. Standard errors in parenthesis and all coefficients are significant at 1 percent level.

Table A.1.6: ENDOWMENT EFFECT AND NON-IPO TRADING INTENSITY

Dep. Var:	Months Since Listing									
I(Holds IPO Stock)	0	1	4	8	11	12	13	16	20	24
	0 Non-IPO transaction									
In the Month	0.723	0.668	0.519	0.523	0.491	0.478	0.459	0.418	0.358	0.369
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Upto the End of Month	0.723	0.646	0.600	0.580	0.539	0.527	0.521	0.494	0.449	0.410
	(0.001)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
	1 Non-IPO transaction									
In the Month	0.738	0.691	0.653	0.439	0.304	0.350	0.396	0.491	0.428	0.362
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Upto the End of Month	0.738	0.763	0.737	0.596	0.582	0.563	0.563	0.546	0.477	0.433
	(0.001)	(0.001)	(0.002)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
	2 to 5 Non-IPO transactions									
In the Month	0.569	0.475	0.408	0.343	0.383	0.325	0.352	0.422	0.496	0.313
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Upto the End of Month	0.569	0.577	0.648	0.659	0.641	0.636	0.629	0.614	0.587	0.544
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	6 to 10 Non-IPO transactions									
In the Month	0.517	0.410	0.324	0.311	0.287	0.295	0.303	0.357	0.354	0.270
	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Upto the End of Month	0.517	0.470	0.496	0.522	0.516	0.508	0.502	0.489	0.477	0.447
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	11 to 20 Non-IPO transactions									
In the Month	0.518	0.390	0.285	0.278	0.290	0.276	0.281	0.343	0.318	0.232
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
Upto the End of Month	0.518	0.425	0.408	0.434	0.434	0.429	0.425	0.413	0.398	0.380
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	$>$ 20 Non-IPO transactions									
In the Month	0.471	0.336	0.238	0.254	0.249	0.233	0.227	0.296	0.259	0.190
	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)	(0.006)	(0.007)	(0.005)	(0.005)	(0.005)
Upto the End of Month	0.471	0.384	0.317	0.293	0.291	0.288	0.286	0.281	0.272	0.252
	(0.004)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

The sample includes all IPOs that occurred 24 months before the end of our portfolio data in March 2012. The total sample size is 1,090,346 accounts in each month. Standard errors in parenthesis and all coefficients are significant at 1 percent level.

Table A.1.7: ENDOWMENT EFFECT FOR INVESTORS WHO SELL PAST RANDOMLY ALLOTTED STOCK

		Months Since Listing						
I(Buy IPO Stock)		0	1	2	3	4	5	6
		Panel A: Full sample of IPO Lotteries						
	$\bar{y_{tr}}$	0.453	0.315	0.331	0.349	0.319	0.283	0.304
	$\bar{y_{co}}$	0.034	0.037	0.048	0.048	0.051	0.049	0.054
	ρ	0.419***	0.278***	0.283***	0.301***	0.268***	0.234***	0.250***
	N	33558	21113	15080	13397	11403	9388	8128
		Panel B: Our Sample 54 IPO Lotteries						
	$\bar{y_{tr}}$	0.406	0.302	0.312	0.348	0.300	0.259	0.305
	$\bar{y_{co}}$	0.033	0.038	0.052	0.051	0.051	0.051	0.057
	ρ	0.373***	0.264***	0.261***	0.297***	0.249***	0.208***	0.247***
	N	21997	14176	9195	8946	7486	6248	5463

Table A.1.8: HETEROGENEOUS FIRST-MONTH WINNER EFFECTS BY PRE-EXISTING ACCOUNT CHARACTERISTICS

Dependent Variable: First Month I(IPO Stock Held)	Full Sample	i (Avg. 6 mnths)	i,t All trades (Month after allotment)	i,j,t (Small trades) (Month after allotment)
Winner	0.660***	0.650***	0.698***	0.713**
# of IPOs Allotted				
1 to 2 IPOs	-0.001	-0.0047954	-0.003***	-0.009
3 to 8 IPOs	0.007***	-0.008**	-0.001**	-0.006
> 8 IPOs	0.022***	-0.0036644	0.009***	0.002
Winner ×				
# of IPOs Allotted				
1 to 2 IPOs	-0.062***	-0.032***	-0.043***	-0.034**
3 to 8 IPOs	-0.126***	-0.035***	-0.088***	-0.040**
> 8 IPOs	-0.233***	-0.102***	-0.186***	-0.087**
# of Trades Made				
1 to 2 trades	0.002	0.000	0.008	0.006
3 to 6 trades	0.001	0.005	0.018	0.012
> 6 trades	0.001	0.011	0.002	0.022
Winner ×				
# of Trades Made				
1 to 2 trades	-0.031	-0.140	-0.057	-0.006
3 to 6 trades	-0.096	-0.026	-0.153*	-0.072
> 6 trades	-0.141*	-0.122	-0.119	-0.140
Fraction Past Returns > Listing Returns				
0.01 to 0.15	0.010***	-0.0023914	0.013***	0.017**
0.16 to 0.50	-0.012***	-0.0001963	-0.009***	0.000
> 0.50	-0.021***	0.015*	-0.015***	-0.011
Winner ×				
Fraction Past Returns > Listing Returns				
0.01 to 0.15	-0.124***	0.047**	-0.167***	-0.120**
0.16 to 0.50	-0.040***	0.106***	-0.074***	-0.052**
> 0.50	0.026***	0.189***	-0.004**	0.048**
Winner ×				
Listing Returns (%)				
<= 0	-0.185***	-0.255***	-0.245***	-0.296**
26 to 41 percent	-0.058***	-0.131***	-0.043***	-0.125**
> 41 percent	-0.145***	-0.115***	-0.170***	-0.109**
Winner ×				
Probability of Treatment				
33 to 66 percent	-0.019***	-0.046***	-0.066***	-0.051**
> 66 percent	0.023***	0.003***	-0.021***	0.009
Controls				
Portfolio Size	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes
IPO Share Category Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R-squared	0.64	0.51	0.48	0.54
Number of observations	1,561,497	54,678	85,358	36,467

Dummies are based on quartile breakpoints of the respective distributions.

Table A.1.9: HETEROGENEOUS FIRST-WEEK WINNER EFFECTS BY PRE-EXISTING ACCOUNT CHARACTERISTICS

Dependent Variable: First Week I(IPO Stock Held)	Full Sample	i (Avg. 6 mnths)	i,t All trades (Month after allotment)	i,j,t (Small trades) (Month after allotment)
Winner	0.701***	0.534***	0.610***	0.718***
# of IPOs Allotted				
1 to 2 IPOs	-0.001***	-0.002	0.001	0.000
3 to 8 IPOs	0.003***	-0.002	0.004*	0.000
$>$ 8 IPOs	0.013***	0.005	0.017***	0.011***
Winner $\times$				
# of IPOs Allotted				
1 to 2 IPOs	-0.037***	-0.039***	-0.028***	-0.039***
3 to 8 IPOs	-0.081***	-0.044***	-0.044***	-0.040***
$>$ 8 IPOs	-0.167***	-0.106***	-0.114***	-0.083***
# of Trades Made				
1 to 2 trades	0.004	0.012	0.043	0.034
3 to 6 trades	0.003	0.022	0.099	0.040
$>$ 6 trades	0.020	0.060	0.186	0.087
Winner $\times$				
# of Trades Made				
1 to 2 trades	-0.002	-0.007	-0.003	-0.004
3 to 6 trades	-0.003	0.007	0.000	0.003
$>$ 6 trades	-0.012	-0.024	-0.021	-0.020
Fraction Past Returns $>$ Listing Returns				
0.01 to 0.15	0.007***	-0.002	-0.001	0.007
0.16 to 0.50	-0.008***	0.000	-0.005*	-0.005
$>$ 0.50	-0.014***	0.011*	-0.011***	-0.013***
Winner $\times$				
Fraction Past Returns $>$ Listing Returns				
0.01 to 0.15	-0.152***	0.003	-0.033***	-0.105***
0.16 to 0.50	-0.081***	0.060	0.0023252	-0.057***
$>$ 0.50	-0.007***	0.148***	0.095***	0.035**
Winner $\times$				
Listing Returns (%)				
$<=0$	-0.245***	-0.262***	-0.235***	-0.303***
26 to 41 percent	-0.019***	-0.107***	-0.114***	-0.092***
$>$ 41 percent	-0.105***	-0.048***	-0.074***	-0.060***
Winner $\times$				
Probability of Treatment				
33 to 66 percent	-0.002	0.029***	0.004	0.015
$>$ 66 percent	0.013***	0.059***	0.061***	0.064***
Controls				
Portfolio Size	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes
IPO Share Category Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R-squared	0.64	0.51	0.48	0.54
Number of observations	1,561,497	54,678	85,358	36,467

Dummies are based on quartile breakpoints of the respective distributions.

Figure A.1.1: IPO FREQUENCY

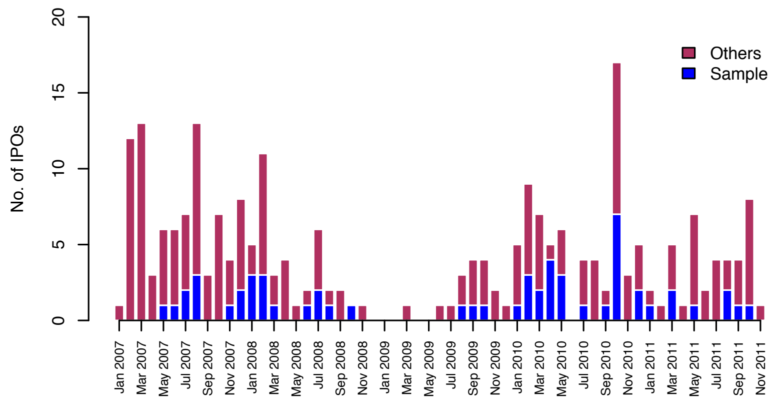


Figure A.1.2: Long-Run Holding Returns on IPOs in India

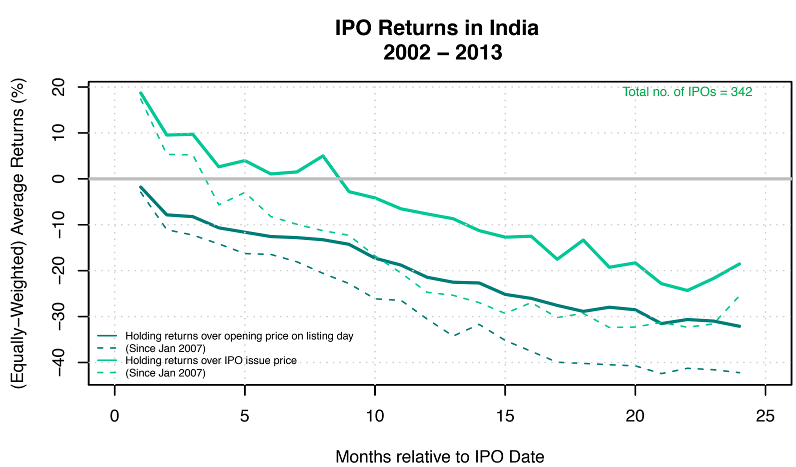
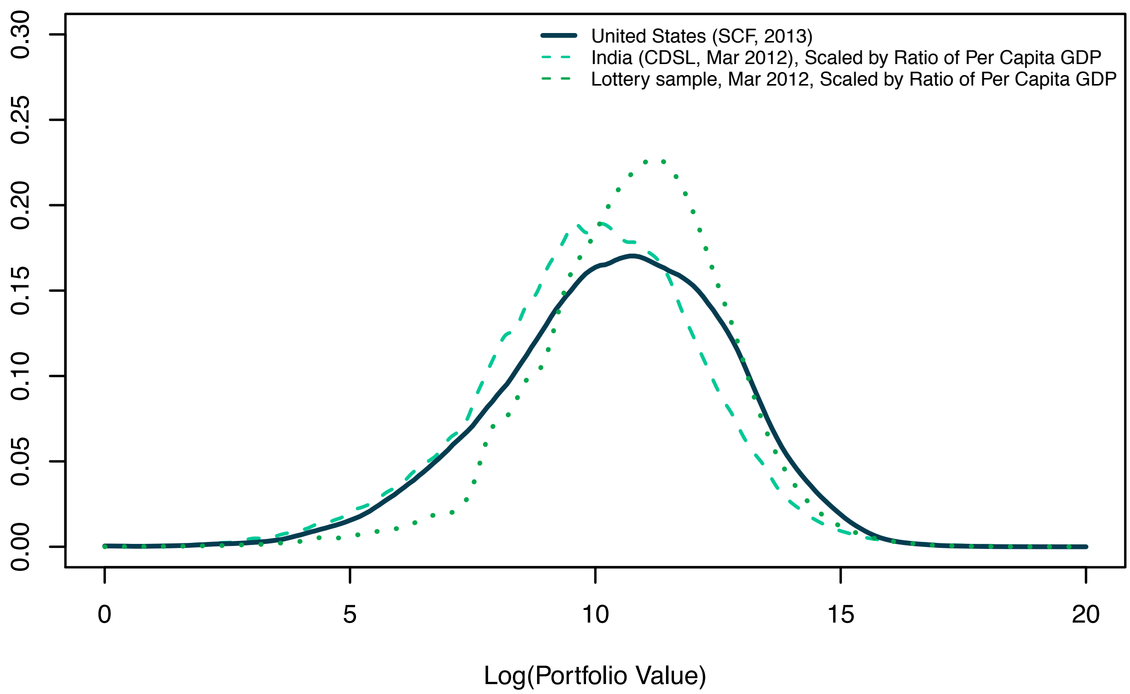


Figure A.1.3: Comparison of Lottery Sample to India and the United States

(a) Portfolio value distribution



(b) Histogram of number of trades

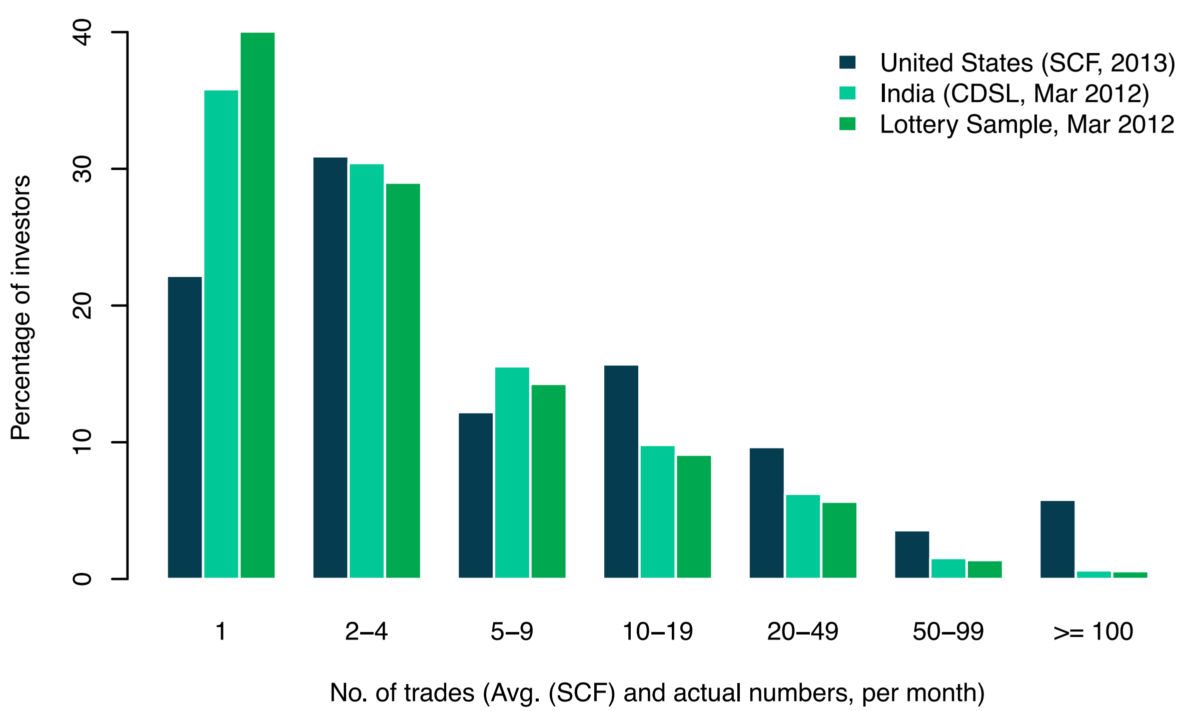


Figure A.1.4: Histogram of no. of investors with trade size $\leq$ allotment size

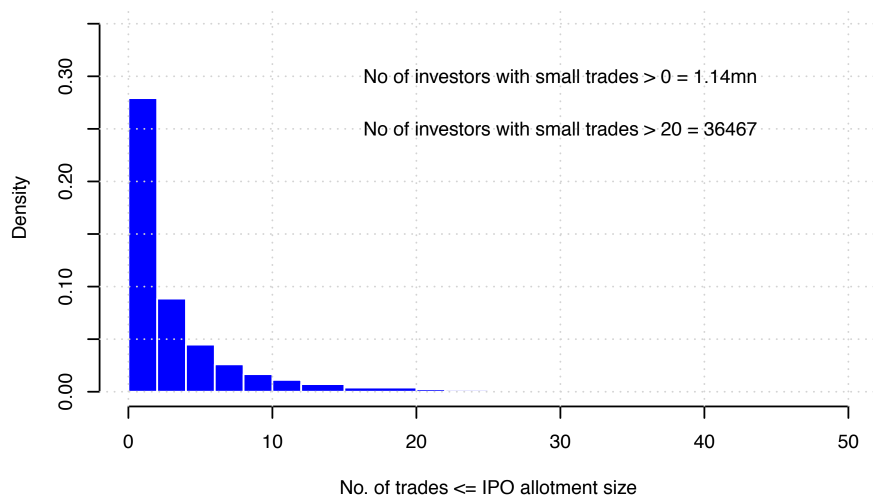


Figure A.1.5: Losers' Propensity to Buy in the IPO sector

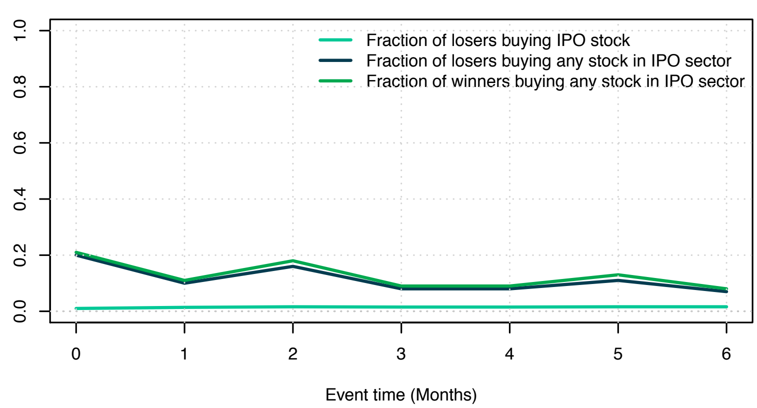


Figure A.1.6: Number of Securities Held (Including IPO Stock)

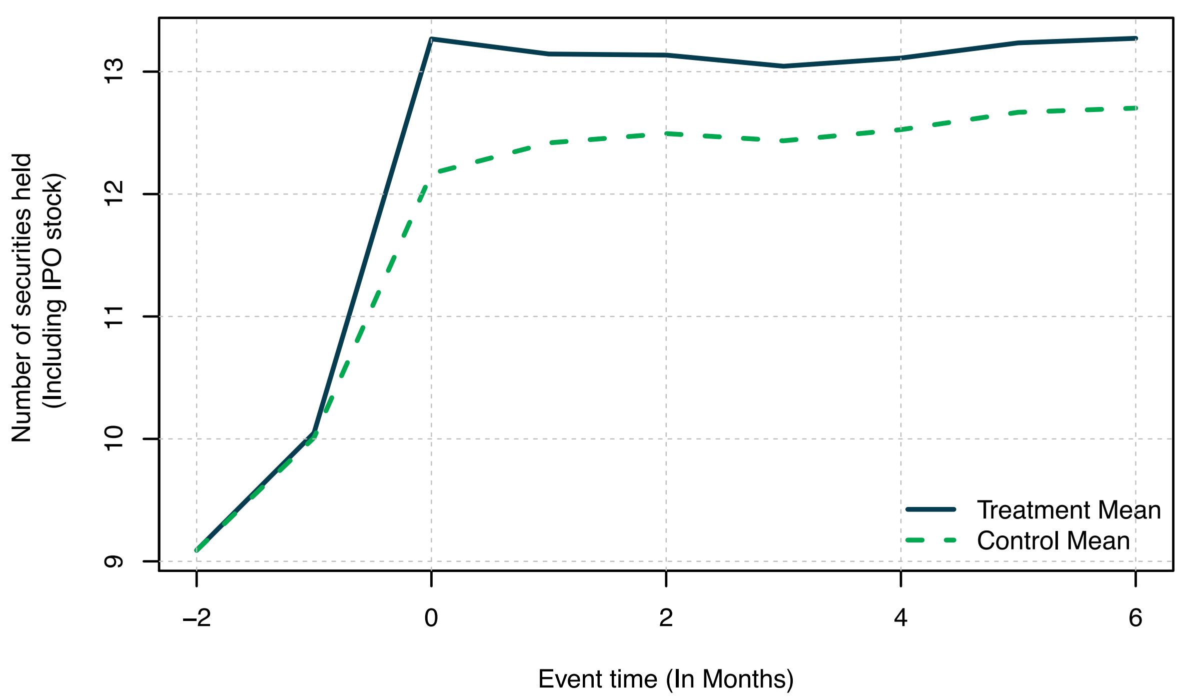
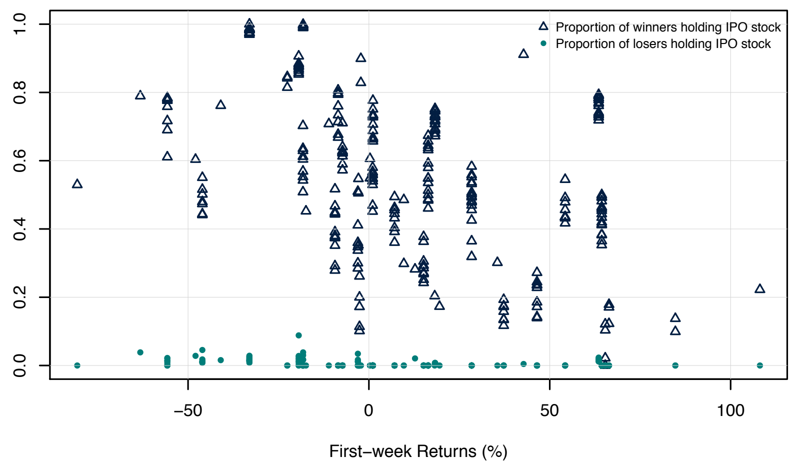
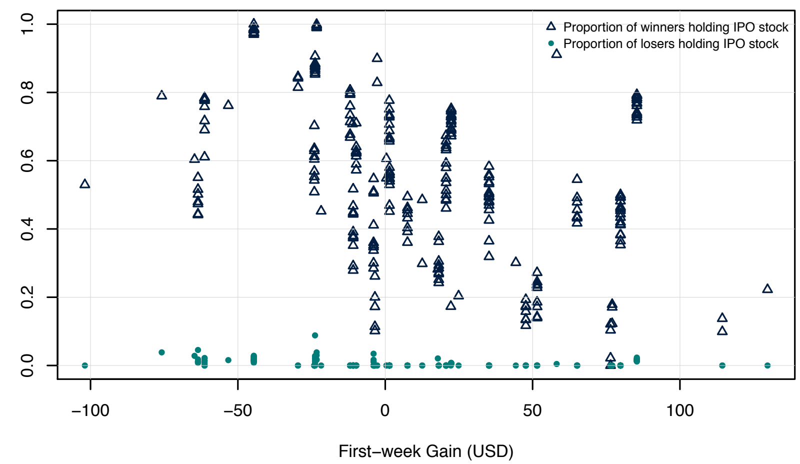


Figure A.1.7: Proportion of Investors Holding IPO Stock and Returns Experience: First-week after Listing

(a) Holding Returns at End of First Full Week after Listing (%)



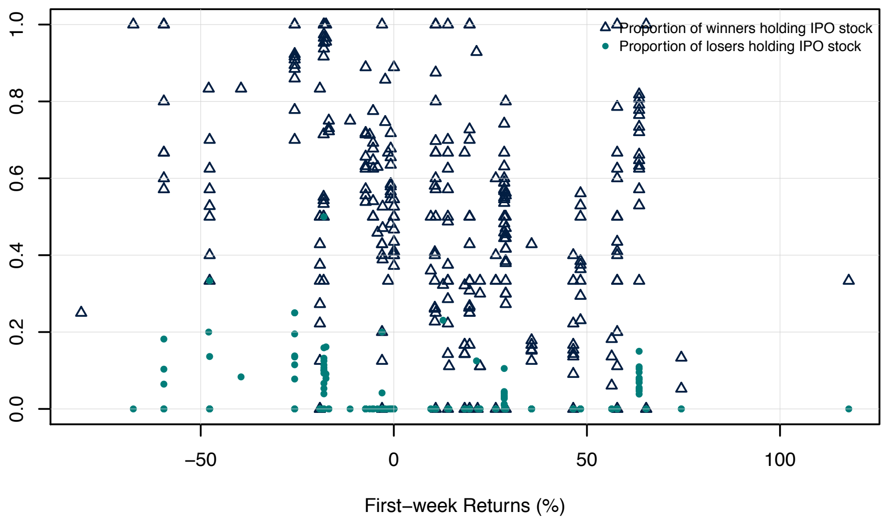
(b) Holding Gain at End of First Full Month After Listing (USD)



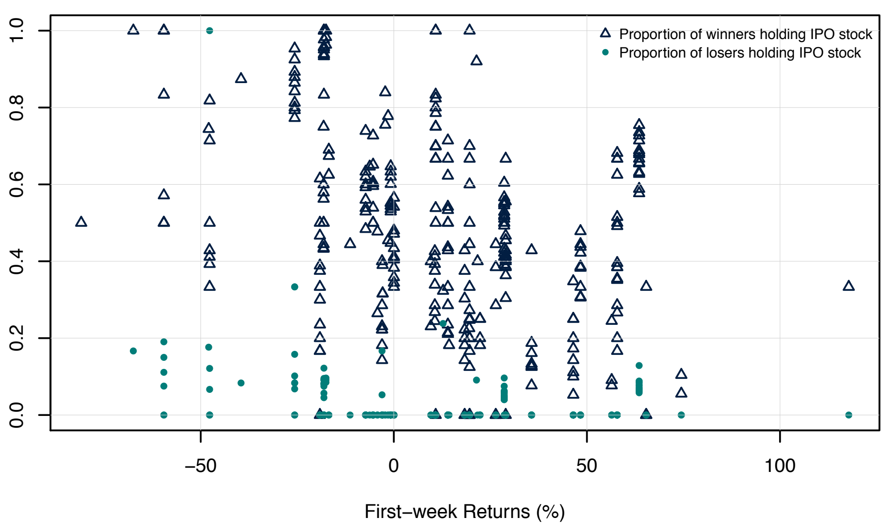
Panels (a) and (b) present estimates at the end of the first full week on the y-axis.

Figure A.1.8: IPO Stock Holding Rates at End of First-week Against First-week Returns

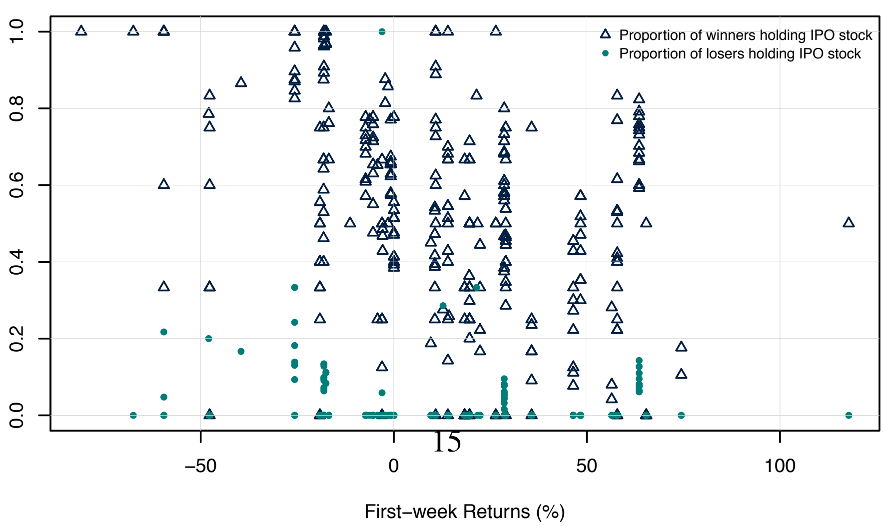
Panel A: Investors with > 20 trades per month on average in six months before lottery



Panel B: Investorswith > 20 trades in first full month after allotment



Panel C: Investors with at least 20 trades <= IPO allotment size in first full month after allotment



A.2 Regulation governing IPO framework in India

The Securities Exchange Board of India (SEBI) Disclosure and Investor Protection Guidelines (till 2009), henceforth "DIP guidelines", SEBI Issue of Capital and Disclosure Requirements Regulation (since 2009), henceforth "ICDR regulations", and Section (19) (b) (2) of the Securities Contract Regulation Rules ("SCRR") made under the Securities Contract Regulation Act, 1956, alongside the Companies Act, 1956 govern the IPO process in India.

Eligibility criteria

An unlisted company may make an initial public offering (IPO) of equity shares if it meets the following conditions alongside at least 1000 investors participate in the IPO process (Rule-set 1): [1]

1. The company has net tangible assets of at least Rs. 3 crores in each of the preceding three full years (calendar years), of which not more than 50% is held in monetary assets. If more than 50% is held in monetary assets, the company has firm commitments to deploy excess monetary assets in its business.

2. The company has a track record of distributable profits (as defined in the Companies Act, 1956), for at least three years out of the immediately preceding five years.

3. The company has a net worth of at least Rs. 1 crore in each of the preceding three full years (calendar years).

4. The aggregate of the proposed issue and all previous issues in the same financial year in terms of size does not exceed five times its pre-issue networth as per the audited balance sheet of the last financial year.

When a company does not fullfil these requirements, it can still undertake an IPO provided the following conditions are fulfilled (Rule-set 2):[2]

[1]See Page 15-16, Section 2.2.1 of DIP guidelines, which is similar to Chapter II of the ICDR regulations, accessed on 20 April 2015. They can be accessed at `http://www.sebi.gov.in/guide/sebiidcrreg.pdf` and `http://www.sebi.gov.in/guide/DipGuidelines2009.pdf`

[2]See Page 18, Section 2.2.2 (i) - (iv) of the DIP guidelines, identical to the conditions in ICDR regulations, accessed on 20 April 2015 at `http://www.sebi.gov.in/guide/sebiidcrreg.pdf` and `http://www.sebi.gov.in/guide/DipGuidelines2009.pdf`

1. The issue is made through the book-building process, with *at least 50% of net offer to public* is allotted to Qualified Institutional Buyers (QIBs), failing which all subscription amount will have to be refunded.[3]

2. The minimum post-issue face value of capital will be Rs. 10 crores.

A.3 Allocation procedure

All 54 IPOs in our sample are book-built IPOs, where the net offer to public is allocated according to the same procedure.[4] All book-built IPOs need to mandatorily achieve a minimum of 90% of the initial intended issue.[5] When a company undertakes a 100% book-built issue, the following percentage of issue will have to be initially set aside for the following investor categories:[6]

1. *Not less than* 35% of the net offer to public will be made available to *retail investors*

2. *Not less than* 15% of the net offer to public will be made available to *non-institutional investors*

3. *Not more than* 50% of the net offer to the public shall be made available for allocation to QIBs.

When the company does not fulfill the criteria set in Rule-set 1, then condition (3) above is *mandatory*. Further, when the company undertakes an IPO under the SCRR, the percentage requirements become 30% (retail investors), 10% (non-institutional investors) and a *mandatory* 60% to QIBs. Any shares set-aside for employees of the company is also considered to be under the "retail investor" category.[7]

Once the bidding is complete, if any of the investor categories are under-subscribed (subject to the allocation rule above), then, with full disclosure and in conjunction with the stock exchange,

[3]QIBs are defined under Chapter I, definition (zd) of the ICDR regulations (Page 6). This includes mutual funds, venture capital funds (domestic and foreign), a public financial institution, banks, insurance companies and so on.

[4]See Section 11.3.5 (i) of DIP guidelines accessed on 20 April 2015.

[5]See ICDR (2009), Chapter I (14) (1), page 13

[6]The Indian regulator, SEBI, introduced the definition of a retail investor on August 14, 2003 and capped the amount that retail investors could invest at 50,000 rupees per brokerage account per IPO. This limit was increase to 100,000 rupees on March 29, 2005, and again increased to 200,000 rupees on November 12, 2010. See Section 11.3.5 (i), footnotes 480,481,482,483 on Page 216 of the DIP guidelines. "Non-institutional buyers" are all those who are not QIBs and Retail Investors - see Chapter I, definition (w) on Page 5 of ICDR regulations.

[7]Note that this has been inferred from Section 11.3.5 (i), read with footnotes 480-483 on Page 216 of the DIP guidelines.

a company can reallocate the shares to the other investor categories.[8] However, the QIB category cannot be under-subscribed if the IPO is undertaken under Rule-set 2 or Section (19) (2) (b) of the SCRR.

While the regulation provides for alternative in the event of under-subscription, in reality, this occurs more frequently with non-institutional investors. Data from our sample of 54 IPOs show that non-institutional buyers are almost always under-subscribed. Retail investors are therefore very important to achieve the minimum of 90% of the initial intended issue, without which the IPO will fail.

In our sample of 54 IPOs, firms issue under both the SCRR and the DIP/ICRR paths. Further, the *ex-post* percentage of total final public issue to retail investors can be higher than the aforementioned values. This will have to be explicitly disclosed at the time of allotment of an issue. In our sample, nearly one-third of the total (final) issue size is always allotted to retail investors. Figure A.3.1 plots the percent of issue to retail investors who are *not* employees of the company.[9]

Finally, the Indian regulator, SEBI, introduced the definition of a retail investor on August 14, 2003 and capped the amount that retail investors could invest at Rs. 50,000 per brokerage account per IPO. This limit was increased to Rs. 100,000 on March 29, 2005, and once again increased to Rs. 200,000 on November 12, 2010. This regulatory definition technically permits institutions to be classified as retail when investing amounts smaller than the limit, but over our sample period, we verify using independent account classifications from the depositories that this hardly ever occurs, and accounts for a minuscule proportion of retail investment in IPOs. We simply remove these aberrations from our analysis.

A.4 The Probability of Treatment

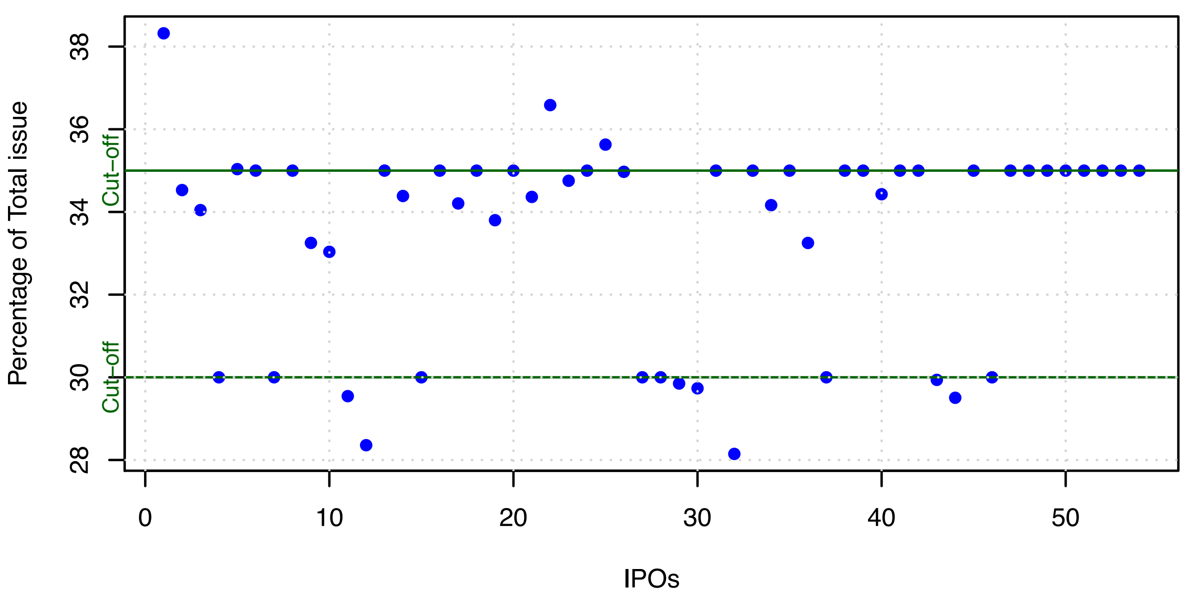
Let S be the total supply of shares that the firm decides to allocate to retail investors. Let $c = 1,...,C$ index "share categories," which are integer multiples of the minimum lot size x for which investors can bid. The set of possible numbers of shares for which investors can bid is therefore: $x, 2x, ..., Cx$.[10]

[8] See DIP guidelines (2009), Section 11.3.2 (v) read with 11.3.5 (i) and 11.3.5 (iv) (Pages 217-219).

[9] For IPOs with values less than 30% of issue, the remainder of the share comes from employees of the firm.

[10] Note that the minimum lot size is also the mandatory lot size increment.

Figure A.3.1: PERCENTAGE OF TOTAL ISSUE ALLOCATED TO RETAIL INVESTORS (EXCL. EMPLOYEES)



Let a_c be the total number of applications received for share category c. The total demand D for an IPO with C share categories is then:

$$D = \sum_{c=1}^{C} cxa_c. \tag{1}$$

Retail oversubscription v is then defined as:

$$v = \frac{D}{S}. \tag{2}$$

As described in case (1) in the paper, if $v \leqslant 1$ at the ceiling price, then all investors get the shares for which they applied, and if $v > 1$, one of cases (2) or (3) will apply.[11]

In the latter two cases, the first step is to compute the allocations for each share category under a proportional allocation rule, and compare these allocations to the minimum lot size x.

Let $J \leq C$ be the share category such that share categories $c \in [J, ..., C]$ receive proportional allocations which are greater than or equal to x, and share categories $c' \in [1, ..., J)$ receive proportional allocations which are less than x. If $J = 1$ then we are in case (2), otherwise we are in case (3).

In either case, investors in share categories $c \geqslant J$ receive a proportional allotment $\frac{cx}{v}$, and a total number of shares equalling $\sum_{c=J}^{C} \frac{cx}{v} a_c$. However, investors in share categories $c' \in [1, ..., J)$ cannot receive the minimum of x shares (since J is the cutoff share category, i.e., $\frac{(J-1)x}{v} < x$). Let Z be the remainder of shares to be allotted, i.e.,[12]

$$Z = S - \sum_{c=J}^{C} \lfloor \frac{c}{v} xa_c \rceil. \tag{3}$$

These are the shares allocated by lottery in case (3). Note that in this lottery, the possible outcomes are winning the minimum lot size x with probability p_c, or winning nothing with probability $1 - p_c$.

By regulation, the probability of winning in share categories $c' \in [1, ..., J)$ must be exactly pro-

[11] At this stage it is possible that some shares will be added to the pre-specified supply to retail investors if employees and/or institutional investors participate in amounts less than they are offered. However, total firm supply is restricted by the overall number of shares that the firm decides to issue, which is fixed prior to the commencement of the application process for the IPO. Thus, it is not possible for firms to add more shares in response to greater than expected demand.

[12] By regulation, the shares to be allotted $\sum_{c=J}^{C} \frac{c}{v} xa_c$ is rounded to the nearest integer.

portional to the number of shares applied for, meaning that in expectation, investors will receive their proportional allocation. That is, for share categories $c' \in [1, ..., J)$:

$$\frac{p_{c'}}{p_{c'-1}} = \frac{c'x}{(c'-1)x} = \frac{c'}{c'-1}. \tag{4}$$

The combination of equation (4) and the fact that the total remaining shares are described by equation (3) gives us:

$$\sum_{c'=1}^{J-1} (p_{c'}) x a_{c'} + \sum_{c'=1}^{J-1} (1 - p_{c'}) \times 0 = Z. \tag{5}$$

Solving (5), we get that $p_{c'} = \frac{c'}{v}$ of winning exactly x shares in share categories $c' \in [1, ..., J)$.

In general, the probability of winning increases proportionally with the number of share lots bid for c, and decreases with the overall level of over-subscription v. This implies that the probability of winning will vary across share categories within IPOs, as well as across IPOs. In other words, there may be some self-selection of investors into share categories – that is, by applying for more share lots, they increase the probability of winning. However, conditional on two investors applying for the *same* share category in the same IPO, the investor chosen to actually receive the shares will be random. In other words, the relevant control group is the set of investors *within* the same share category who were unsuccessful in the lottery.

A.5 Relationship between Endowment Effect and Randomized Experience

While the fact that such experienced lottery winners are so much more likely to hold the stock than similarly experienced losers is suggestive that experience does not eliminate this anomaly, it is possible that this correlation is confounded by selection effects. For example, our experience measure might be correlated with some unobserved factor that causes more experienced winners to hold the stock more than similarly experienced lottery losers (i.e., the negative effect of experience on the divergence of holdings between winners and losers are somewhat canceled out by this omitted factor when we estimate correlations). We note that this type of selection contradicts the most commonly assumed selection bias as discussed in List (2003) and List (2011): those with more experience are typically thought to be *more* likely to trade in endowment experiments due to unobserved factors, because it is natural to think that to survive in a market (and gain experience) one would need to eliminate inefficient behavior such as falling prey to endowment effects. Nonetheless, we cannot rule out the presence of such unobserved factors based on correlations alone.

To make some progress on this issue, our second analysis exploits the random assignment of previous lotteries to provide a sharper comparison of whether the behavior of more experienced lottery players converges more than that of less experienced lottery players.[13] We find evidence consistent with such convergence: when we compare the behavior of randomly chosen winners and losers in future IPOs, we find that those who have previously won IPOs have smaller estimated endowment effects in the future. But, similar to the experience correlations discussed above, the rate of learning appears to be slow. Overall, the evidence from these two types of analyses suggests that while experience does substantially reduce this particular endowment effect, it seems unlikely that experience eliminates this anomaly completely.

Table A.5.1 presents the results of ten such comparisons. We focus on the 10 pairs of lotteries in our data with the largest number of applicants that applied to both lotteries within the pair. For example, the first row analyzes the behavior of the 156,120 applicants who applied to both BGR Energy Systems and Future Capital IPOs. We term the first IPO as "IPO *a*" (BGR in this case) and the second IPO as "IPO *b*" (Future Capital in this case). BGR Energy listed on January 3, 2008 and had a listing return of 66.9 percent. However, after listing BGR had a 29.9 percent loss up until the date that Future Capital listed (February 1, 2008). We are interested in whether the allotted BGR applicants show smaller endowment effects in their behavior regarding Future Capital.

To estimate whether BGR winners show a smaller endowment effect in decisions regarding Future Capital we estimate the following regression model, where the sample only includes accounts that applied to both BGR and Future Capital:

[13] While our main comparison of lottery winners and losers constitutes a randomized experiment, our comparison of past winners and losers in future lotteries has one potentially important selection issue: the choice of whether to participate in future IPOs may depend on previous experience. We discuss how this type of selection might affect this set of experience estimates.

$$y_{i,c_a,c_b} = \alpha + \beta_1 \text{Win-b}_{i,c_a,c_b} + \beta_2 \text{Win-b}_{i,c_a,c_b} * \text{Win-a}_{i,c_a,c_b} + \beta_3 \text{Win-a}_{i,c_a,c_b} + \gamma_{c_a,c_b} + \varepsilon_{i,c_a,c_b} \tag{6}$$

y_{i,c_a,c_b} is an indicator for whether account i in share category c_a of IPO a and in share category c_b of IPO b holds the IPO b stock at the end of the first month after IPO b was listed (i.e. at the end of February 2008 in the case of the BGR/Future Capital pair represented in the first row. Note that a given account can only appear in exactly one share category in IPO a and one share category in IPO b because an account can only apply once to a given IPO. Win-b$_{i,c_a,c_b}$ and Win-a$_{i,c_a,c_b}$ are indicators for whether account i was allocated in IPO b and IPO a respectively. γ_{c_a,c_b} are fixed effects for each possible pair of share category combinations across IPOs a and b. We include these fixed effects to control for any factors that are common to people who chose to apply to given share categories in IPOs a and b.

We are primarily interested in the coefficient β_2, which tells us the difference in the estimated endowment effect in IPO b based on whether the account won the lottery in IPO a. Column (8) of Table A.5.1 reports β_2 for the ten largest pairs of IPOs in terms of the number of applicants who applied to both. We would expect β_2 to typically be negative, because observing the performance of the IPO stock after listing should cause greater convergence in the behavior of winners and losers in the next IPO.[14] Consistent with this, we estimate negative coefficients in nine of the ten examples studied here. On the other hand, the estimated coefficients are small, suggesting that an account would require a very large number of these experiences before the endowment effect was eliminated (similar to our conclusion in the previous analysis).

It is important to note that there are two potential mechanisms underlying our negative estimates of β_2. The first is that winning shares in IPO a causes a given account to exhibit the endowment effect less in a future IPO (i.e. a causal effect of experience). The second is that the types of players who choose to apply to IPO b after winning shares in IPO a are differentially selected to be the type who

[14] For example, lottery winners who experience a negative open return should sell future allotments faster, thus reducing the convergence. Similarly, lottery losers who observe the IPO stock having a positive listing return should be more likely to purchase the stock on the open market.

have lower endowment effects (i.e. a selection effect). Previous studies, such as List (2011), focus on separating these two effects, but this is difficult in our setting as the choice to apply for a future IPO is endogenous.

However, we argue that in this particular analysis the joint effect is a primary object of interest; it tells us whether the two forces of investors learning from experience as well as the force of experiences driving some investors out of the market, lead to lower market anomalies (such as the endowment effect) over time. If winning previous lotteries makes an account more likely to apply (which we show in Anagol et al. (2015)), then these results would suggest that there will be a modest reduction in endowment effects under the selection mechanism as well. For example, suppose the entire difference in behavior of past winners and losers in future IPOs is due to selection, this would mean that winning past lotteries induces a selection of investors who exhibit lower anomalies in the future.

Table A.5.1: EFFECT OF WINNING PREVIOUS LOTTERIES ON PROPENSITY TO HOLD FUTURE IPO ALLOCATIONS

IPO A				IPO B			Differential
Name	Listing Date	Listing Return (%)	Open Return (%)	Name	Listing Date	Observations	Winner Effect
BGR	1/3/2008	66.88	-29.86	Future Capital	2/1/2008	156120	-0.024***
							[0.003]
Career Point	10/6/2010	48.71	-15.92	P&S Bank	12/30/2010	34488	-0.026***
							[0.009]
Omaxe	8/9/2007	29.03	-27.54	BGR	1/3/2008	34574	-0.010
							[0.006]
Vishal Retail	7/4/2007	75.01	187.50	BGR	1/3/2008	49150	-0.022***
							[0.007]
Omaxe	8/9/2007	29.03	-35.48	Future Capital	2/1/2008	34418	0.011*
							[0.006]
Vishal Retail	7/4/2007	75.01	187.50	Future Capital	2/1/2008	46816	-0.025***
							[0.007]
Meghmani	6/28/2007	75.00	-14.44	BGR	1/3/2008	29304	-0.080***
							[0.008]
Omnitech	8/14/2007	75.00	-3.67	BGR	1/3/2008	29276	-0.038***
							[0.010]
BGR	1/3/2008	66.88	-10.32	P&S Bank	12/30/2010	48469	-0.001
							[0.007]
Future Capital	2/1/2008	36.47	-81.82	P&S Bank	12/30/2010	54337	-0.008
							[0.007]

The dependent variable is the fraction of the winning allotment held. Standard errors in brackets and mean of the dependent variable for lottery losers in the parentheses. *,**,*** denote significance at the 10, 5 and 1 percent levels.

A.6 Alternative Explanations for the Endowment Effect

Wealth Effects and House Money Effects. Thaler and Johnson (1990) introduced the idea that decision makers may be willing to take more risk when they have recently experienced a gain. In our setting, lottery winners experience a 42 percent gain on their IPO stock allotment upon listing, whereas lottery losers (most likely) do not experience a large gain on the cash returned to them as part of their endowment. Under the house money effects explanation, lottery winners choose to hold the IPO stock because they are more willing to take risk after experiencing the listing gain (i.e. they view holding the stock as "gambling with house money"). Note that a traditional wealth effect would deliver the same result, although the wealth would presumably be spread across all of the securities the investor holds rather than increasing the allocation to the IPO stock alone.

One prediction of the wealth effects/house money hypothesis is that we would expect lottery winners tendency to hold the stock to *increase* as they experience greater gains on the IPO stock (because the amount of house money earned is greater in this case). Contrary to this, we find that the endowment effects are typically smaller as the gains experienced in the IPO stock increase. Figure 1 (a) and (b), in the main paper, shows little relationship between the listing gain earned on the stock and the tendency for the winners to hold the stock; house money effects would predict that those with the largest listing gains should be most likely to take the risk of holding the IPO stock longer. And, moving forward in time, Figures 1 (c) and (d) in the paper show that the endowment effects get substantially smaller as returns on the IPO stock in the first month increase.

Monetary Transaction Costs. One possible explanation for the divergence we find between lottery winners and losers holding the IPO stock is that monetary transaction costs make it unprofitable for lottery winners to sell the stock, and simultaneously make it unprofitable for lottery losers to buy the stock. Note that under this explanation, both winners and losers have the same optimal holding levels, but the cost of getting to that optimal holding level outweighs the benefits of arriving at the optimal holding level.

In terms of monetary transaction costs, there are two primary types of costs to consider: (1)

brokerage commissions, and (2) securities transactions taxes.[15] Our data does not include information on brokerage commissions costs, and we are not aware of any representative datasets on commissions for Indian equity accounts. However both the Bombay and National Stock Exchanges specify that brokers may not charge more than 2.5 percent of the valuation of a transaction as a brokerage fee. In our sample the average IPO allotment is worth 150 USD, so the commissions to buy or sell the full allotment are on average less than 3.75 USD. In reality commissions are typically much lower than the statutory maximums because of competition amongst brokers. We hand collected brokerage commissions from twenty major retail brokerage firms over our sample period (2007-2012) and found the commissions to vary between .3 to .9 percent of the transaction value, much less than the statutory maximum of 2.5 percent (Table A.6.1). Securities transaction taxes are an additional 14.5 basis points (Mohanty, 2011). Given these estimates it seems unlikely that monetary transactions costs would cause such a large divergence between the holdings of lottery winners and losers of the IPO stock.

Multiple Applications Per Household. It is worth noting here that regardless of the number of applications that households put in, if they only make their buying or holding decisions based on a comparison of their valuation of the stock versus the market price (as they would in the simplest expected utility model), then they should all end up owning the same number of shares after the stocks lists. This is because the randomization of share allocations is orthogonal to valuations, meaning that the simplest expected utility model will continue to predict no endowment effect regardless of whether households are submitting multple applications or not.

A further possibility to consider is that households have some target number of shares, and this target is lower than the total amount they would be allotted across all their applications. For example, suppose that all households decide that they would like to hold one allotment, and pursue an application strategy consistent with this desire. To fix ideas, consider an example where there are 400 applications to a given category that come from 200 households, with 2 applications per household. Let the probability of winning the IPO be p. Given the randomization, this scenario implies that

[15]In addition to the direct securities transaction tax (12.5 basis points paid to central government during our sample period) there are three additional taxes charged at the time of transaction: a service tax on brokerage (10.3 percent of the brokerage commission paid to central government), a stamp duty (1 basis point of transaction value paid to state government), and a SEBI turnover fee (1 basis point of transaction value paid to stock market regulator).

there will be $200p^2$ households with two winning accounts, $400p(1-p)$ households with one winning account and one losing account, and $200(1-p)^2$ households with no winning accounts. With a one share per household target, we might see an endowment effect because households will tend to hold in the accounts in which they won, and not purchase in the accounts in which they lost. More specifically, $200p^2$ households with two wins will each sell one share, $400p(1-p)$ households will hold the share they won, and do nothing else on the losing application, and the $200p(1-p)$ households who lost will buy one share each. The total fractions conditional on winning and losing will therefore exhibit an "endowment effect."

The key problem with this explanation is that the randomization of the lottery will naturally also produce many households where none of the accounts are allotted ($200p(1-p)$ in the above example), yet these households should have the same target number of shares to hold as households that were allotted (recall that winning and losing the lottery is orthogonal to target share demands). If this target share explanation is correct then we should observe many loser accounts buying on the first day, especially when the probability of winning is low on average (as it is in our data, $p = 0.36$, see Table 2). However, the fact that lottery losers do not in general buy the IPO stock is strongly inconsistent with this kind of multiple applications per household theory explaining our results.

Flipping Incentives. In the United States, IPO shares are typically rationed to brokerage clients who have provided large value to the brokerage firm. There is substantial anecdotal and empirical evidence to suggest that brokerages discourage investors from quickly selling their allotted shares, in particular by threatening that "flippers" will be denied future IPO allocations (Aggarwal, 2003). Thus, in the United States, it is possible that allottees of IPOs choose to hold the stock much longer than statistically similar non-allottees because they believe selling the stock will reduce their chances of being allotted future IPOs.

A few factors make this explanation less plausible in the Indian setting. First, Table 3 in the paper shows that lottery winners and losers are balanced in terms of their tendency to quickly sell IPO stocks in the past; the fraction of lottery winners who sold an IPO in the first month after allotment (28.7 percent) is almost exactly equal to the fraction of lottery losers who sold an IPO in the first month after allotment (28.6 percent). If the lottery process penalized "flippers" we would expect lottery winners to be less likely to have quickly sold an IPO in the past. Second, the lottery process is publicly advertised after allocations are made (i.e. the fraction of allottees randomly chosen appears in newspaper articles etc.), and it is generally common knowledge that winners are chosen at random; therefore, it is not clear why investors would assume that selling their shares quickly would hurt them in future allocations.

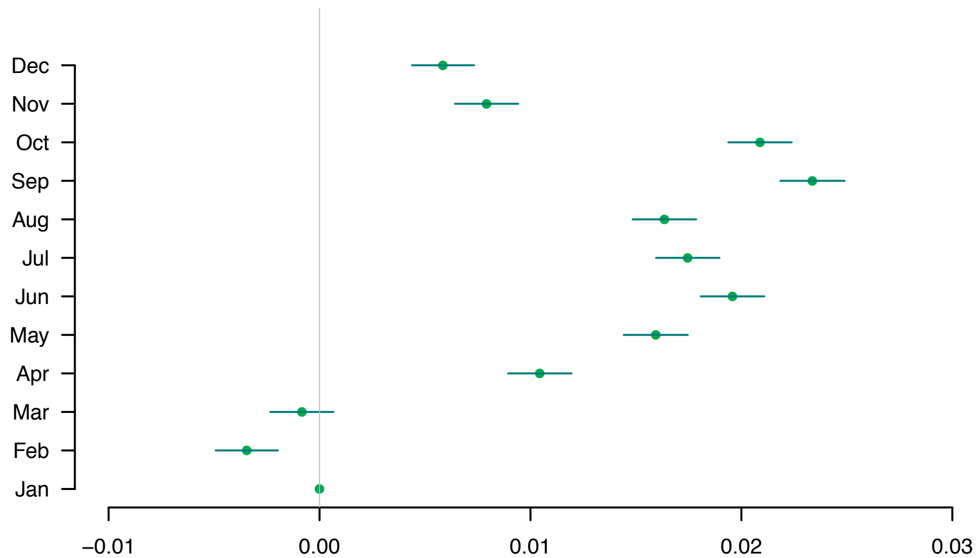
Tax Motivated Behavior. Two distinct tax issues might influence the holding behavior of lottery winners in the Indian context. First, the capital gains tax rate changes from 15 percent if a holding is sold within a year (a short term gain/loss) to zero if the holding is sold after one year. Investors holding the IPO stock at a gain might therefore have an incentive to wait until after one year of allotment to avoid paying the short term capital gains tax. Under this hypothesis we would expect the endowment effect estimates to drop substantially between the twelfth and thirteenth month after allotment. However, Appendix Table A.1.4 in the paper shows only a small drop in the divergence between winner and loser holdings going from the twelfth to thirteenth month.

The second issue is that in India short term (less than 1 year) losses on stocks can be applied to short term gains on stocks to reduce capital gains tax liability.[16] Constantinides (1984) notes that under these types of tax incentives, and the presence of transactions costs, investors should slowly realize their losses with the volume of sales peaking right before the end of the fiscal year. This might give lottery winners an incentive to generally hold their shares that have experienced losses until the end of the Indian fiscal year (March 31), and then sell them in right before the end of the fiscal year. Under this hypothesis we would expect the divergence between buyers and sellers to drop in March as lottery winners sell their losses on IPO stocks as tax offsets.

To investigate this hypothesis we regress a dummy for whether an account holds the IPO stock on an indicator for being a winner in the lottery, a full set of interactions of the winner indicator with the calendar month of the year, and a full set of interactions between the winner indicator and the number of months since the IPO was allotted. The regression also includes the calendar month and number of months since IPO indicators separately. We include the month since IPO indicators as the

[16]During the period of our study short term capital gains were taxed at 15 percent. There was no long term (greater than one year) capital gains tax, and therefore no opportunity for long term tax loss offsets.

Figure A.6.1: Endowment Effects By Month of the Year



treatment effects have a strong pattern of declining after allotment, and we want to separately analyze the relationship between certain calendar months from any correlation between calendar month and time since allotment.

Figure A.6.1 plots the calendar month interactions with the winner variable along with 95 percent confidence intervals. These coefficients show how much smaller or larger the winner effect on holding the IPO stock is, based on the calendar month of the observation. The omitted calendar month is January. Consistent with the tax hypothesis, we see that the months January, February, and March do have the lower estimated endowment effects relative to the other months of the year. Quantitatively, however, this effect is quite small, ranging from 1 to 2 percentage points. Given that the overall propensity of winners to hold the stock relative to losers is between 45 and 55 percent over the first twelve months after the allotment, the results suggest it is unlikely that tax offset motivated behavior explains a large fraction of the endowment effect in this setting.

Table A.6.1: Monetary Transaction Costs: Brokerage Charges in India

	A/c opening charge (Rs.)	Annual maintenance charge (Rs.)	Brokerage (delivery) Paise (%)	Brokerage (Intra-day) Paise (%)
Angel Broking	390	300	30	6
Bonanza	600	275	50	5
Canmoney	200	250	(0.35)	(0.1)
Geojit BNP Paribas	800	400	30	3
HDFC securities	999	550	25 (0.5)	25 (0.05)
ICICI Direct	975	450	(0.55)	(0.05)
IDBI Paisabuilder	700	350	(0.5)	(0.08)
Indiabulls	1350	450	(0.3)	(0.05)
India Infoline	750	0	50	5
Kotak Securities	750	50	59	6
Motilal Oswal	550	900	(0.5 – 0.9)	(0.25 – 0.40)
Networth Direct	200	440	(0.3)	(0.03)
Reliance Money	950	210	(0.3)	(0.035)
Religare	499	300	30	3
SBI	500	386	75	5
Sharekhan	750	441	(0.5)	(0.1)
SMC India	499	0	30	3
Ventura	1000	400	45	5
Way2Wealth	350	332	0.5	0.05
5Paisa	500	250	0.25	0.05

These numbers are for online “cash” trades only. Advalorem charges in percent are in parenthesis. Flat charges are in “paise” (1/100th of a rupee).

A.7 Estimate of the First Day Endowment Effect

To estimate the short-run endowment effect in this setting, we adopt an algorithm to determine whether or not a sale of a stock happened on the day the stock began trading on the market. We use the daily high and low price data in the month of listing, and classify a stock to have potentially traded on days where the selling price falls within that range. This provides us with the likelihood of trade having happened on specific days of the listing month. For example, if an investor sells a stock at Rs. 30 per stock, and this is within the high-low range on three specific days of the listing month in which this trade happened, then the likelihood of the trade is 0.33 for each of these days of the month. In order to be most conservative with this classification, we further classify first-day sale (for the treatment group) and first-day purchase (for the control group) as follows: If $0 < Pr(\text{Sale on first day}) < 1$, then we assume that they sold on the first day and set the probability of sale on the first day to 1. This over-estimates the likelihood of sale on the first-day for the treatment group. If $0 < Pr(\text{Purchase on First Day}) < 1$, then we assume that they purchased on the first day and set the probability of purchase to 1. This over-estimates the likelihood of purchase on the first day for the control group. The difference between the conservative estimates of the (weighted) average holding propensity for the treatment group and the (weighted) average purchase propensity for the control group on the first-day of trading provides us the estimate of the first-day endowment effect.

Other measures of the endowment effect such as the fraction of allotment and Value of IPO Shares Held in USD are less precise as they require additional assumptions. For example, suppose we want to calculate the fraction of allotment held at the end of the first day for an investor who was allotted 50 shares and sold 20 shares during the month. The algorithm requires assumptions to determine which of the days 2/5th of the allotted shares were sold. These assumptions, for instance, will involve choosing whether they were sold fully in one trade or in multiple trades of different lot size. This is important as the selling price used in the identification algorithm will change depending on the size assumptions and hence will impact the likelihood of trade on a given day. Similarly, measures of the value of IPO shares held will be affected by such auxiliary assumptions, and the portfolio weight of the IPO stock will require assumptions about holdings in the portfolio as well. To simplify the presentation of results, we choose not to report these additional measures of the endowment effect (rows 2 to 5 of Table 4) for the listing day.

B Model Appendix

In this model appendix, we consider a range of behavioral microeconomic models of choice which have the potential to explain the endowment effects that we observe in India's IPO lotteries. We set up and solve several models, namely, two versions of the Kőszegi and Rabin (2006) expectations based reference dependent utility model, including one which more closely matches the features of the real-world setting that we observe, and the Weaver and Frederick (2012) reference price theory of the endowment effect. Throughout, we discuss the features of the experimental results that are consistent and inconsistent with the predictions of these models.

We present two models of an agent with reference dependent utility, where the agent's recently formed expectations of future outcomes constitute their reference points as in Kőszegi and Rabin (2006).

C Expectations Based Reference-Dependent Utility Models

As in Kőszegi and Rabin (2006), an agent's reference points in these models are determined by his expectations of outcomes, which in turn are based on his planned actions. Naturally, his planned actions also depend on his expectations of outcomes. This dual dependence gives rise to the need for an equilibrium concept. We begin by solving for the personal equilibrium (PE), which involves identifying conditions under which the agent has no incentive to deviate from a particular planned action of interest, conditional on the plan generating a particular expectations-based reference point. In certain cases, we go further and discuss the conditions under which the plan is also a preferred personal equilibrium (PPE), i.e., the plan which delivers the highest level of utility of all possible PEs.

Our approach in all cases is to enumerate all possible plans of action open to the agent, and the expectations associated with each such plan. We then solve for the conditions/parameter values under which certain plans dominate others, using the PE and PPE concepts. We are of course most interested in the conditions under which the plan corresponding to the "endowment effect" which we observe in our field experiment, is a PE/PPE.

All three variations of the model which we consider share the same basic preference specification, namely:

- The agent has expectations based reference dependent preferences with loss-aversion:

$$u(z|r) = m(z) + \mu(m(z) - m(r)).$$

  In the above, $m(.)$ is consumption utility, and $\mu(.)$ is gain-loss utility relative to the referent, r.

- We assume piecewise linear gain-loss utility, i.e.,

$$\mu(y) = \begin{cases} \eta \cdot y & \text{if } y \geq 0 \\ \eta \cdot \lambda \cdot y & \text{if } y < 0 \end{cases},$$

  where λ is the degree of loss aversion (we assume $\lambda > 1$).

- We also make a set of additional simplifying assumptions. First, we assume that $\eta = 1$, so:

$$\mu(y) = \begin{cases} y & \text{if } y \geq 0 \\ \lambda \cdot y & \text{if } y < 0 \end{cases}.$$

  Second, we assume that $m(z) = z$. Third, we assume that all gambles that the agents face are binary, as we describe in each case below.

We begin by describing how the results and setup of Ericson and Fuster (2011), originally set up as a model for the endowment effect for consumption goods, apply in our context. We then move on and formally consider the setup of Sprenger (2015) in which we are able to treat stocks as gambles rather than consumption goods, and conclude this section with a more elaborate model that more accurately captures features of our real-world setting.

C.1 Ericson and Fuster (2011) Model

Ericson and Fuster (2011) model the typical participant in an endowment effects experiment within the exchange paradigm. In their experimental application, an agent is randomly assigned a mug or a pen, and then expects, with probability b, that they will be given the opportunity to trade the object later. In their experiment, they manipulate this probability b, and observe the associated rates of exchange of the mug and the pen.

To use the identical set up to theirs in this version of the model, we simply re-label the objects "stock" (to represent the allocation of IPO stock) and "cash" (to represent the refund of cash that the lottery losers get, which could be used to purchase the stock). It is worth noting that such a model abstracts from a number of important features of our setting. Two particularly important features are that 1) in reality, the agent knows that the stock or cash were assigned randomly with some probability, and 2) the stock is itself a gamble whose value changes over time. We present formal models with these additional features further on in this appendix.

In the Ericson and Fuster (2011) model, the decision process of lottery winners and losers is symmetric. The model will therefore yield the same result whether the agent is randomly allocated the stock or cash, so it is easier to consider the case in which the agent is randomly allotted the stock (i.e., the lottery winners in the data).

We denote by s the agent's expectation of what the stock will be worth in the future, and by the variable c the value of the cash returned to lottery winners. To fix ideas, note that a standard expected-utility decision maker would choose to hold the stock if $s > c$, and sell the stock if $s < c$, regardless of whether they randomly win or lose the stock in the lottery.

In this model, once the lottery winner learns that he has won the lottery, but just prior to the stock listing, he makes a plan about whether or not to sell the stock after it lists on the exchange. The agent assumes that with probability b he will be given the opportunity to trade the stock post-listing. This is an exogenously specified parameter in the Ericson and Fuster (2011) experiment, and we argue that in the Indian stock market setting in which investors know that they can trade the stock at very low explicit transactions costs, that b is very high, and possibly 1.

Consider the case in which the lottery winner plans to trade the stock after it lists. For this plan to be an equilibrium, it must be the case that its expected utility is greater than the expected utility from planning to continue to hold the stock post-listing.

The expected utility from the plan to sell the stock is:

$$EU(\text{sell}|\text{plan to sell}) = bU(c|r) + (1-b)U(s|r) \tag{7}$$

In equation (7), $U(c|r)$ is the utility from selling the stock and keeping the cash. This utility has three pieces; the direct utility of consumption (c), the gain-loss utility from comparing the utility of holding cash to the reference point of holding the cash (this is simply 0), and the gain-loss utility from exchanging the stock for cash $(c - \lambda s)$, compared to a reference point of holding the stock. This final piece captures the fact that the agent feels a loss from "losing" the stock while gaining cash, beyond any difference in expected value between the cash and the stock. In other words, this piece captures the pain of the agent giving up the endowed item (the stock).

The agent will follow through on his plan to trade if there is no incentive to deviate once the reference point is set, to a plan to hold the stock. That is, once the agent has reached the state of the world in which he can exchange and follows through with the plan, his utility is the left hand side of the below inequality. If indeed he decides to deviate at this point, the utility he receives is the right hand side of the inequality. For there to be no incentive to deviate (i.e., for exchange to be a personal equilibrium or PE), the inequality must be satisfied:

$$\begin{aligned} c + (1-b)(c - \lambda s) &\geq s + b(s - \lambda c) \\ c &\geq s\frac{1 + \lambda + b(1-\lambda)}{1 + 1 - b(1-\lambda)} \end{aligned}$$

As b approaches 1, this inequality approaches

$$c \geq s\frac{2}{1+\lambda}$$

meaning that for values of loss aversion greater than 1, there are larger ranges of preferences for cash for which exchange is the PE. Unfortunately, as Ericson and Fuster (2011) show, "keep" may also be a PE in such cases, depending on parameter values (i.e., if $c \leq (1+\lambda)s$ and exchange is not a PE). The concept of the PE is therefore ambiguous in this case.

As in Ericson and Fuster (2011), we therefore go further to understand how PPEs would work in our setting. Note that the gain-loss utility pieces are weighted by their probability of occurrence (with probability b, the agent can go ahead and exchange, so compares the outcome to the planned action, and with probability $1-b$, is constrained from exchanging, and compares the outcome to the reference point of holding the stock), and the utility from holding the stock in the state of the world where the agent does not have the opportunity to trade is $U(s|r) = s + b(s - \lambda c)$. Plugging these into the equation above, we have:

$$EU(\text{sell}|\text{plan to sell}) = b(c + (1-b)(c - \lambda s)) + (1-b)(s + b(s - \lambda c)$$

The expected utility of holding the stock given the agent's plan to hold the stock is simply the consumption value of the stock s, because regardless of whether the agent is given the opportunity to trade, the agent will end up holding the stock (so the outcome and the expectations based reference point are always equal). Thus, the condition that determines whether the agent prefers the plan where he sells the stock to the plan to hold the stock is determined by:

$$\begin{aligned}
EU(\text{sell}|\text{plan to sell}) &> EU(\text{hold}|\text{plan to hold}) && (8)\\
b(c + (1-b)(c - \lambda s)) + (1-b)(s + b(s - \lambda c)) &> s \\
bc + (1-b)s + b(1-b)(c - \lambda s + s - \lambda c) &> s \\
c - s + (1-b)(1-\lambda)(c+s) &> 0 && (9)
\end{aligned}$$

Equation (8) is identical to Proposition 1 of Ericson and Fuster (2011). When $b = 1$, the final equation simplifies to $c > s$, i.e., the agent's decision of whether to go through with the plan to sell the stock versus holding the stock is exactly the same as that of an expected utility decision maker. If the agent believes the stock is worth less than the refunded cash amount, he will sell the stock, and if he believes the stock is worth more than the refunded cash amount, he holds.

The intuition for the result is that when $b = 1$ the agent does not develop an expectations based reference point based on being forced to hold the stock; because this reference point is not developed, the agent does not feel an unusual added loss from selling the stock. If on the other hand, he was potentially forced to hold it, he would feel such an unusual added loss. Hence in this case, the decision to trade (or not trade) is determined by consumption values only. Since the problem is symmetric for lottery losers, the same condition will determine whether they will choose to buy the stock versus holding the cash.

In our natural experiment, randomization should equalize the fraction of lottery winners and losers that believe that $s > c$. As a result, this model would predict that we should see equal fractions of the two groups holding the IPO stock. However, our data refutes this prediction. This suggests that the model of expectations based reference points studied in Ericson and Fuster (2011), which is able to explain their laboratory evidence on endowment effects for consumption goods, is unlikely to explain our findings.

A drawback of applying this model to our setting is that it models the stock as having a deterministic value like a consumption good. This is clearly unrealistic. We therefore turn to a more elaborate model which allows the stock to have stochastic payoffs.

C.2 Sprenger (2015) Model

We now introduce an expectations based reference-dependent preferences model in which the agent views the stock as a lottery with probabilistic payoffs. We assume that the stock price can go up by h, with probability q in the aftermarket, or down by l with probability $1 - q$. The model takes as given that an agent has either won or lost the initial IPO allocation lottery, and simply studies the potential plans the agent could make about holding, selling, or buying the stock given these allocation lottery outcomes.

The basic idea of the endowment effect for risk, following Proposition 1 from Kőszegi and Rabin (2007), is that an agent is less risk averse when they compare a potential lottery to a lottery reference point, relative to when they compare the same lottery to a fixed reference point of cash.

To flesh this out, we first consider the case of the lottery loser. The idea of the model is that because the lottery loser is endowed with cash, holding cash constitutes his expectations based reference point. The agent then has two possible plans to consider. The first plan is to simply not purchase the stock. The expected utility in this case is just the value of the cash returned in the lottery c; there is no gain-loss utility piece because the agent compares holding cash to the reference point of holding cash, yielding zero.

We next derive the condition necessary for the agent to not wish to deviate from their plan to hold the cash, i.e., the condition that makes the agent's plan to not hold the stock a personal equilibrium (PE).

The expected utility of deviating from the plan of not buying the stock is:

$$\begin{aligned}
EU(\text{buy stock}|\text{plan to not buy}) &= q(c+h+q(h)+(1-q)(h))+\\
&\quad (1-q)(c-l+q\lambda(-l)+(1-q)\lambda(-l))\\
&= q(c+h+h)+(1-q)(c-l-\lambda l)\\
&= q(c+2h)+(1-q)(c-(1+\lambda)l)\\
&= c+q2h-(1-q)(1+\lambda)l
\end{aligned}$$

The agent will choose not to deviate from the plan to not buy the stock if:

$$\begin{aligned}
EU(\text{plan to not buy}|\text{plan to not buy}) &> EU(\text{buy stock}|\text{plan to not buy})\\
c &> c+q2h-(1-q)(1+\lambda)l\\
(1-q)(1+\lambda)l &> 2qh\\
\frac{1+\lambda}{2} &> \frac{qh}{(1-q)l} \qquad (10)
\end{aligned}$$

Note that when $\lambda = 1$ this condition simplifies to $0 > qh+(1-q)l$. That is, with no loss aversion, the agent prefers holding the cash only if the expected return on the stock is less than zero.

When $\lambda > 1$ there are two forces that affect whether the agent will stick to their plan of not buying the stock. First, as loss-aversion increases, this condition is more likely to hold. This is because buying the stock involves the possibility of taking on losses. Second, as the potential gains on the stock qh increase relative to the potential losses $((1-q)l)$, the incentives to deviate from the plan and buy the stock increase. This is obvious – the expected returns with gains, and more importantly, the chance of experiencing large losses gets smaller. If we assume $h = l$, so that the expected return on the stock is only determined by q, and when $\lambda = 2$, we have that q must be less than $\frac{3}{5}$ for not buying to be a PE.

Now consider the lottery winner. We assume that the lottery winner, who is endowed with the stock, has an expectations-based reference point of holding the stock. The lottery winner also faces two possible plans. The first of these is to hold the stock. The expected utility of this plan is:

$$\begin{aligned} EU(\text{hold stock}|\text{plan to hold stock}) &= q(c+h+(1-q)(h+l))+(1-q)(c-l+q\lambda(-l-h)) \\ &= c+q(h+(1-q)(h+l))+(1-q)(-l+q\lambda(-l-h)) \\ &= c+qh+(1-q)(-l)+q(1-q)(1-\lambda)(h+l) \end{aligned}$$

We can then calculate the expected utility of the lottery winner from deviating from this plan:

$$\begin{aligned} EU(\text{hold cash}|\text{plan to hold stock}) &= q(c+q\lambda(-h)+(1-q)(l)) \\ &\quad +(1-q)(c+q\lambda(-h)+(1-q)(l)) \\ &= c+q\lambda(-h)+(1-q)l \end{aligned}$$

The investor will follow through on his plan to hold the stock if:

$$EU(\text{hold stock}|\text{plan to hold stock}) > EU(\text{hold cash}|\text{plan to hold stock})$$

$$c+qh+(1-q)(-l)+q(1-q)(1-\lambda)(h+l) > c+q\lambda(-h)+(1-q)l$$

If we assume that $h = l$, this condition simplifies to $\sqrt{q} + q > 1$, meaning that $q > 0.4$.[17]

Combining the two no-deviation conditions, the expected return on the stock must fall in the following range for an investor to choose to stick with their plan of holding cash when they lose the lottery, and holding the stock when they win the lottery:

$$0.4 < q < 0.6$$

This result suggests that the endowment effect can be a PE (i.e, the lottery loser does not wish to deviate from their plan of holding cash, and the lottery winner does not wish to deviate from their plan to hold the stock), for a small range of beliefs about the probability of the stock going up. The reason for the narrow range, in part, is the somewhat restrictive assumption that $h = l$, i.e., symmetric gains and losses on the stock.

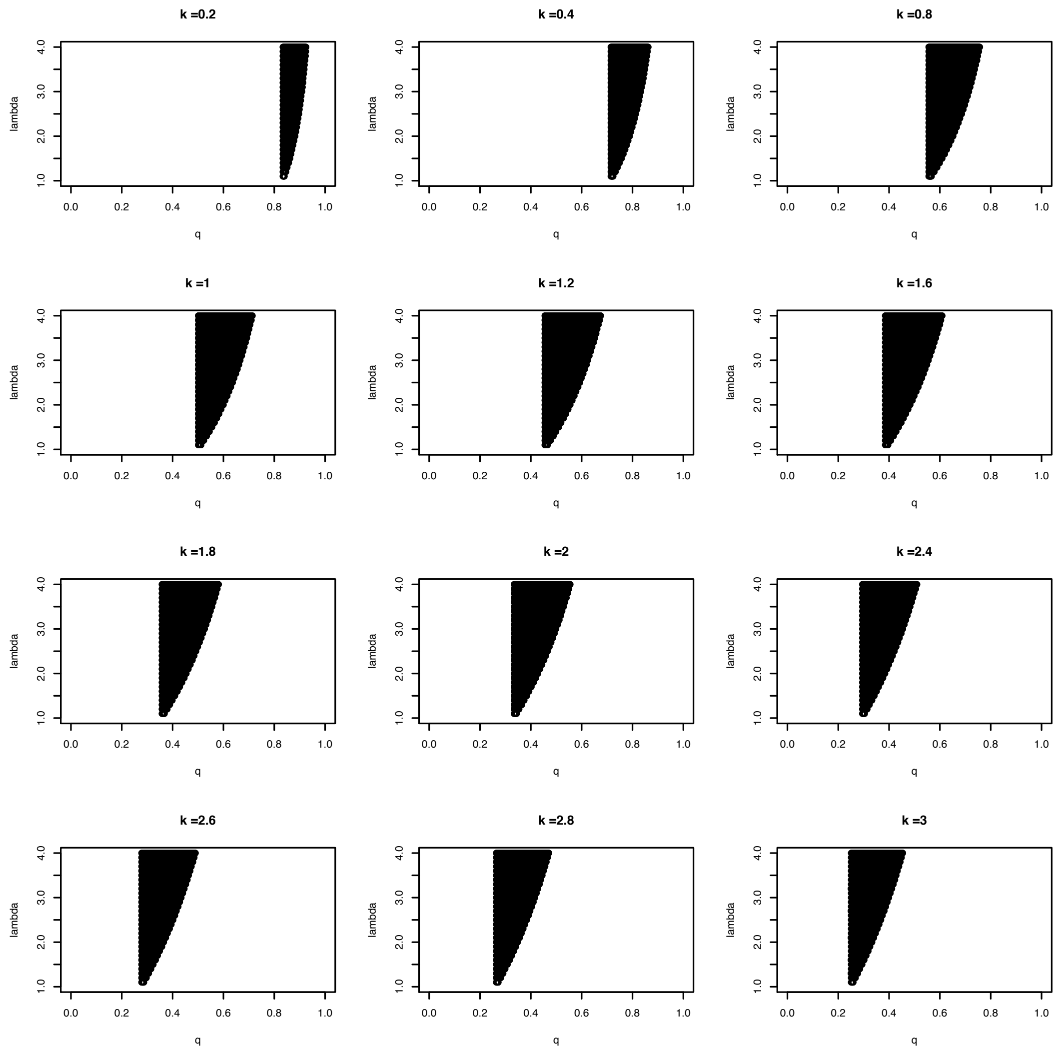
We therefore consider a more generalised version of the model, where gains can be proportional to losses, with factor of proportionality k, i.e., $h = kl$. In this case, the two no-deviation conditions become:

$$\frac{1+\lambda}{2} > \frac{qk}{(1-q)}$$

$$qk + q - 1 + q(1-q)(1-\lambda)(k+1) > 1 - q\lambda k - q$$

The graph below outlines the range of q, k, and λ for which the endowment effect plan is a PE. The graph shows that for different values of k, there are different ranges of q for which the endowment effect plan is a PE.

[17] We only need to consider the positive root of $\sqrt{q}$, since $0 < q < 1$, i.e., this condition can never hold for the negative root of q.



The intuition for the result is that expected gains need to be in a medium range to deliver the result. Put differently, if there are very high expected gains on the stock, investors deviate to the "always hold," plan. In contrast, very low expected gains lead investors to deviate to the "never hold" plan in the model. However, medium size expected returns can be delivered in multiple ways. Such feasible parameter ranges are achievable either through beliefs about (positively or negatively) skewed payoffs on the lottery, or beliefs about the likelihood of experiencing gains versus losses. To see this, note that medium-size expected returns can be delivered through expectations of small probabilities of highly positively skewed payoffs (small q, large k), as in the bottom row of figures, or expectations of high probabilities of small payoffs (large q, small k) as in the top row of figures.

Another aspect of these graphs is worth noting. The range of values for which the endowment effect plan is a PE is larger when q is small and k is large. This is because of the first of the no deviation conditions above – when q approaches 1, there is no value of λ for which the endowment effect plan can be a PE, even if the loss is far larger than the gain in these cases. The reason is because the positive payoff is a "sure thing" when q approaches 1, so the agent places less and less weight on the loss state. However, there are larger ranges in which the endowment effect plan can be a PE when q is smaller and k is large – in a sense, even the prospect of large positive payoffs are not enough to entice the agent to buy when they lose the lottery, since the kink in the utility function λ "offsets" potentially large gains even with smaller losses.

C.2.1 Preferred Personal Equilibrium (PPE) Conditions

For the lottery loser, the PPE condition is:

$$\begin{aligned} EU(\text{plan to not buy}|\text{plan to not buy}) &> EU(\text{buy stock}|\text{plan to buy}) \quad (11) \\ c &> c + qh + (1-q)(-l) + q(1-q)(1-\lambda)(h+l) \\ q(1-q)(\lambda-1)(h+l) &> qh + (1-q)(-l) \quad (12) \end{aligned}$$

For the lottery winner, the PPE condition is:

$$\begin{aligned} EU(\text{hold}|\text{plan to hold}) &> EU(\text{sell}\mid\text{plan to sell}) \quad (13) \\ c + qh + (1-q)(-l) + q(1-q)(1-\lambda)(h+l) &> c \\ qh + (1-q)(-l) &> q(1-q)(\lambda-1)(h+l) \quad (14) \end{aligned}$$

Note that conditions (11) and (13) contradict each other. That is to say, agents holding the cash when they lose the lottery and holding the stock when they win the lottery cannot simultaneously constitute a PPE. The intuition for this result is that in this model, planning to buy the stock and then following through on it (as a lottery loser) delivers exactly the same payoff as planning to hold the stock and following through on it (as a lottery winner). Similarly, planning not to buy the stock and following through on this plan as a lottery loser gives the same payoffs as planning to sell the stock and following through on this plan as a lottery winner. Given this symmetry of payoffs, and the (plausible) assumption that the randomized endowment does not change the investor's beliefs about future returns (i.e., q, h, l) or loss aversion (λ), the model cannot simultaneously generate losers who want to stay out of the stock and winners who want to stay in the stock.

Thus, it is possible that we could observe the endowment effect as an outcome of this model because investors are playing their PEs. However, we note, as does Sprenger (2015), that this behavior cannot be a PPE of the model.

We now turn to a model which more realistically captures features of our empirical setting, including the fact that agents are randomly assigned the IPO stock in an initial lottery, following which they decide to either buy, sell, or hold the IPO stock.

C.3 A Reference-Dependence Model of IPO Market Lotteries

Summary. In this model, an agent enters an IPO lottery, and wins (loses) with probability p $(1-p)$ and receives (does not receive) the stock. After the agent learns whether or not she won the stock, the stock lists on the exchange at a price greater than the price paid for the stock (i.e., there is a listing gain). Following realization of the listing gain, the investor chooses whether to hold or sell the stock if she wins the lottery, and whether or not to purchase the stock if she loses the lottery. Finally, after this choice is made, the stock either goes up with probability q, or down with probability $1-q$.

We analyze the model exactly as suggested by Kőszegi and Rabin (2006). Before the lottery results are announced, the agent considers three possible plans of action. The first, we which term the "never hold" plan, is to sell the stock immediately if she wins, and not buy the stock if she loses. The second plan ("always hold"), is to hold the stock if she wins and buy if she loses the lottery. If the agent follows through on either of these first two plans then there is no endowment effect, because the agent has the same position in the stock at the end of the model *regardless* of whether they were randomly assigned the stock in the lottery. The third "endowment effect" plan is to hold the stock if she wins, but not purchase the stock if she loses the lottery.[18]

As before, in the model, the agent's decisions affect her utility in two ways. First, her choices affect her consumption directly (i.e., by the amount of the value of the stock or cash held at the end of the model). Second, the agent feels gain-loss utility when comparing her actual outcome to her expectations-based reference point. For example, she might experience a utility gain from comparing an outcome of winning the lottery and holding a stock which goes up to losing the lottery and buying a stock which goes down.

Our goal in analyzing the model is to determine the conditions under which the agent does not deviate from the endowment effect plan to either the always hold plan or the never hold plan.[19] When we solve the model, we find that the expectations based reference dependent framework can generate an endowment effect as a PE in this setting.[20] It is worth considering the forces in the model that makes an agent choose the endowment effect plan. The first force is the direct consumption benefit arising from the stock's after-listing performance. These direct consumption benefits alone will never move an agent towards the endowment effect plan – if she expects the stock will do well in the aftermarket, this moves her towards the always hold plan, and if she expects the stock to do poorly, this moves her towards the never hold plan. This means that the reference-dependent gain-loss utility piece (which is the non-standard part of this utility formulation) is what pushes the agent towards the endowment effect plan.

Before the full derivation of the model below, we explain the intuition for how the addition of the first stage lottery into the model changes things relative to the previous version of the model which did not include this stage. In the model, low anticipated probabilities of winning the lottery are more likely to generate the endowment effect since the agent compares how she feels when she wins the lottery to how she feels when she loses; however, as the probability of winning the lottery becomes higher, this comparison becomes less and less important because the agent's reference points are less and less affected by her expectations of losing the lottery. Put differently, when p, the probability of

[18]There is a fourth possible plan, where the agent chooses to sell the stock if she wins the lottery but purchase the stock if she loses the lottery. Given that this plan is not empirically relevant, we omit it from our discussion here.

[19]This is the condition necessary to guarantee that sticking to the endowment effect plan is a personal equilibrium (PE).

[20]But not, once again, as a PPE, as in Sprenger (2015).

winning the lottery, is close to one the agent's decisions are essentially determined by the expected return on the stock. If this is positive she will prefer the always hold plan, and if negative, she prefers the never hold plan.

Looking at our empirical estimates of how the endowment effect varies with the probability of winning a given lottery (Table 6), in the full sample, we find that when p goes from zero to one, the endowment effect does decline, consistent with this prediction. However the decline is small, and sometimes reverses in sign with the smaller samples of more active traders. To summarize, while this model can generate endowment effects as a PE, the data provide only partial support for the prediction that the endowment effect should be influenced by the agent's expected probability of winning the lottery.

Model Details and Solution. To model the IPO setting in our empirical analysis, we include both the lottery which results in the agent being awarded the stock or not, as well as the (simplified) evolution of the stock price in the after-market – which we also model as a binary lottery.

The model begins with the agent applying to receive one share of a stock following the IPO allocation process described in the text. We then consider a set of possible plans and associated reference points, and solve for the PE in this setup. We identify parameter values for which we observe the endowment effect plan (where the agent holds the stock when they win, and does not purchase the stock if they lose) is a PE, and relate this back to our empirical tests.

- The first lottery that the agent faces is the IPO lottery. We model this as follows: with probability p the agent wins the IPO lottery and receives one share of the stock, and with probability $1-p$ the agent loses the lottery, and receives cash c as a refund.

- The value of the stock that the winners receive at the point at which they win the lottery (and immediately before the stock is listed) is $s=c$. This realistically represents features of the lottery process, and captures the idea that lottery losers and winners start with the same amount of money before the stock is listed.

- The stock lists on the exchange at a value $s+x$, where x is the listing gain. For simplicity, we assume $x>0$, as 40 of the 54 IPOs in our empirical analysis had positive listing gains. Note this also amounts to assuming that agents expect a positive listing gain at the time of applying for the IPO.

- The stock trades freely after listing. Winners can choose to sell the stock at $s+x$ in the moment after listing. Losers can choose to buy the stock at $s+x$ in the moment after listing.

- After the stock lists, we also model the evolution of the stock price as a binary lottery. The stock price can either go up by an amount h (with probability q) or go down by an amount l, with probability $1-q$. This means that the final price of the stock is $s+x+h$ with probability q and $s+x-l$ with probability $1-q$. To fix intuition, we can think of these prices as those at the end of the day on which the stock lists.

- All decisions are made before the stock realizes its high or low value.

- We begin by assuming that $l < x$, i.e., the potential loss on the stock, post-listing, on the day that it lists, is modelled as smaller than the listing gain. This assumption will be important in determining whether certain outcomes are encoded as losses or gains (e.g., a lottery winner might not feel the pain of losing when the stock goes down in the after market because they are already sitting on a large listing gain.) We think of this assumption as implying that we are mainly concerned with the short-run, as in our sample of 54 IPOs only 8 had a larger loss from the listing price to the closing price on the first day than the listing gain (in the positive listing gain domain). Later, we analyze the long run case where $l > x$, i.e., the after-market losses could potentially be larger than the listing gain.

- We assume that the agents consume the value of the stock or cash held after the stock achieves its final price.

An agent in this model can have four potential plans which we summarize in Table C.3.1. In Plan 1, the agent sells the stock immediately after listing if she wins the lottery, and chooses not to buy the stock if she loses the lottery. In Plan 2, the agent chooses to hold the stock until the end of the first day if she wins the lottery, and to buy the stock immediately after listing if she loses the lottery. In

Plan 3, the agent chooses to hold the stock until the end of the first day if she wins, but chooses not to purchase the stock if she loses the lottery. Finally, in Plan 4, the agent chooses to sell the stock immediately after listing if they win the lottery, but also to buy the stock after listing if they lose the lottery.

Table C.3.1: Plans of Action

	Lottery Outcome:	
	Win Lottery	Lose Lottery
Plan 1	Sell Stock at $s+x$	Hold cash
Plan 2	Hold Stock, realize $s+x+h$ or $s+x-l$	Buy at $s+x$, realize $s+x+h$ or $s+x-l$
Plan 3	Hold Stock, realize $s+x+h$ or $s+x-l$	Hold cash s
Plan 4	Sell Stock at $s+x$	Buy at $s+x$, realize $s+x+h$ or $s+x-l$

To fix intuition, it is useful to think of Plan 3 as the "endowment effect plan." Under this plan, the agent chooses to make a *different* decision about the stock in the after-market based on whether they are endowed with the stock in the lottery. On the other hand, Plans 1 or 2 do not demonstrate endowment effects, because in both of those cases the agent plans to take the *same* decision on the stock in the after-market (in Plan 1 the agent does not want to hold the stock in the after-market regardless of winning or losing, and in Plan 2 the agent does wish to hold the stock in the after-market regardless of winning or losing). Plan 4 can be thought of as an "anti-endowment effect" plan, where being randomly assigned the stock in the lottery makes the agent *less* likely to want to hold it. To save space we do not formally analyze Plan 4 as it is not empirically relevant in our setting.

Table C.3.2 summarizes the utility consequences of pursuing Plans 1, 2, and 3. Each panel refers to a different plan, and the rows within each panel refer to the four possible states of the world that can occur. "Win" ("Lose") indicates winning (losing) the lottery, and the $\uparrow$ ($\downarrow$) symbol indicates the stock going up (down).

Table C.3.2: Consumption and Gain-Loss Utility Terms for Plans

			Reference State			
Outcome State	Probability	Consumption	Win ↑	Win ↓	Lose ↑	Lose ↓
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Plan 1 (Sell Stock if Win Lottery, Don't Buy Stock if Lose Lottery						
Win ↑	pq	$s+x$	0	0	$(1-p)q(x)$	$(1-p)(1-q)(x)$
Win ↓	$p(1-q)$	$s+x$	0	0	$(1-p)q(x)$	$(1-p)(1-q)(x)$
Lose ↑	$(1-p)q$	s	$pq\lambda(-x)$	$p(1-q)\lambda(-x)$	0	0
Lose ↓	$(1-p)(1-q)$	s	$pq\lambda(-x)$	$p(1-q)\lambda(-x)$	0	0
Panel B: Plan 2 (Hold Stock if Win Lottery, Buy Stock if Lose Lottery						
Win ↑	pq	$s+x+h$	0	$p(1-q)(h+l)$	$(1-p)q(x)$	$(1-p)(1-q)(x+h+l)$
Win ↓	$p(1-q)$	$s+x-l$	$pq\lambda(-l-h)$	0	$(1-p)q(x-l-h)$	$(1-p)(1-q)(x)$
Lose ↑	$(1-p)q$	$s+h$	$pq\lambda(-x)$	$p(1-q)\lambda(-x+h+l)$	0	$(1-p)(1-q)(h+l)$
Lose ↓	$(1-p)(1-q)$	$s-l$	$pq\lambda(-x-l-h)$	$p(1-q)\lambda(-x)$	$(1-p)q\lambda(-l-h)$	0
Panel C: Plan 3 (Hold Stock if Win Lottery, Don't Buy Stock if Lose Lottery						
Win ↑	pq	$s+x+h$	0	$p(1-q)(h+l)$	$(1-p)q(x+h)$	$(1-p)(1-q)(x+h)$
Win ↓	$p(1-q)$	$s+x-l$	$pq\lambda(-l-h)$	0	$(1-p)q(x-l)$	$(1-p)(1-q)(x-l)$
Lose ↑	$(1-p)q$	s	$pq\lambda(-x-h)$	$p(1-q)\lambda(-x+l)$	0	0
Lose ↓	$(1-p)(1-q)$	s	$pq\lambda(-x-h)$	$p(1-q)\lambda(-x+l)$	0	0

The column labelled "Probability" gives the probability of the state occurring (e.g., the probability of winning the lottery and the stock going up is pq). The "Consumption" column shows the final consumption amount in each state of the world under this plan. For example, under Plan 1, the consumption amount if the agent wins the lottery is the value of the stock plus the listing gain, because the agent chooses to sell the stock right after it lists. We also see that under Plan 1, if the agent loses the lottery, the consumption value is just the value of the cash they get back ($c = s$).

Columns (3) - (6) show the gain loss utilities that the agent expects when she compares the current state (the row) to the reference state (the column, r in our notation above). Note that these gain-loss utilities are weighted by the probability that the given reference state would be the outcome state. Intuitively, outcome states that are more likely to happen are more important as reference states compared to outcome states that are unlikely to happen. This weighting scheme follows exactly the weighting procedure of reference points followed in Kőszegi and Rabin (2006), and subsequently utilized for stochastic referents by Sprenger (2015) among others.

For example, Column (3) of the first row gives the expected gain-loss utility when the realized state of the world is Win ↑ and the agent compares this outcome to the ex-ante expectation that the state of the world would be Win ↑; the value in the cell is $pq0 = 0$ because this state occurs with probability pq and there is no gain-loss utility – the realized state of the world is equivalent to the the expectation based reference-point in that particular possible outcome. This logic also shows why the panels always have zeroes on the diagonals–because in those cells the agent is comparing the outcome state to the expectation of that realized state (which are identical), and therefore there is no gain-loss utility.

Column (4) of the first row also has a value of zero because here the agent is comparing winning the lottery and the stock going up to the expectation of the consumption outcome of winning the lottery and the stock going down, but in both of these states the consumption amount is the same (because the agent does not hold the stock in Plan 1).

In Plan 1 the non-zero gain-loss utility pieces only take two other possible values, x or $\lambda(-x)$. When the agent wins the lottery and compares it to losing the lottery, the agent has a gain-loss utility of x (the four upper right cells in Panel A); the agent feels particularly good about winning the lottery because she gets the listing gain she would not have received if she had lost the lottery. When the agent loses the lottery and compares it to winning the lottery, the gain loss utility is $\lambda(-x)$; the agent feels bad about losing the lottery because she compares to the listing gain she would have received had she won the lottery.

The remaining cells follow this logic and show the gain-loss terms. Two auxiliary assumptions are important to note in this context. First, in Plan 2, in the cell where the outcome state is Lose $\uparrow$, and the reference state is Win $\downarrow$, we assume that $x > l + h$, i.e., the loss that the agent feels is because the loss of the listing gain is greater than the difference between the stock price in the up and down states. Second, we assume that the lottery losers do not consume the amount of the listing gain if they buy the stock in Plan 2.

The goal of our analysis is to determine the conditions under which an agent would prefer Plan 3 to *both* Plan 1 and Plan 2. Our analysis proceeds in three steps. First, we derive the condition that makes the agent want to follow through on Plan 3, as opposed to deviating to Plan 1, given that Plan 3 was her plan. Second, we derive the condition that makes the agent want to follow through on Plan 3, as opposed to deviating to Plan 2, given that Plan 3 was her plan. We then combine these two conditions to determine the parameter values that would make an agent choose to prefer following through on Plan 3 versus deviating to either Plan 1 or Plan 2. In other words (without considering Plan 4), we derive the parameter values under which Plan 3 constitutes a PE.

C.3.1 Condition: No Deviation to Plan 1 Assuming Plan 3 is the Plan

We want to calculate $EU[\text{Follow Plan 3}|\text{Plan 3}] - EU[\text{Follow Plan 1}|\text{Plan 3}]$. Table C.3.2 already summarizes $EU[\text{Follow Plan 3}|\text{Plan 3}]$. We compute $EU[\text{Follow Plan 1}|\text{Plan 3}]$ below:

EU[Follow Plan 1 | Plan 3]

	Probability	Consumption	Win $\uparrow$	Win $\downarrow$	Lose $\uparrow$	Lose $\downarrow$
Win $\uparrow$	pq	$s+x$	$pq\lambda(-h)$	$p(1-q)l$	$(1-p)qx$	$(1-p)(1-q)x$
Win $\downarrow$	$p(1-q)$	$s+x$	$pq\lambda(-h)$	$p(1-q)l$	$(1-p)qx$	$(1-p)(1-q)x$
Lose $\uparrow$	$(1-p)q$	s	$pq\lambda(-x-h)$	$p(1-q)\lambda(-x+l)$	0	0
Lose $\downarrow$	$(1-p)(1-q)$	s	$pq\lambda(-x-h)$	$p(1-q)\lambda(-x+l)$	0	0

The table below shows $EU[\text{Follow Plan 3}|\text{Plan 3}] - EU[\text{Follow Plan 1}|\text{Plan 3}]$:

	Probability	Consumption	Win $\uparrow$	Win $\downarrow$	Lose $\uparrow$	Lose $\downarrow$
Win $\uparrow$	pq	h	$^{a}pq\lambda h$	$^{b}p(1-q)h$	$^{e}(1-p)qh$	$^{f}(1-p)(1-q)h$
Win $\downarrow$	$p(1-q)$	$-l$	$^{c}pq\lambda(-l)$	$^{d}-p(1-q)l$	$^{g}(1-p)q(-l)$	$^{h}(1-p)(1-q)(-l)$
Lose $\uparrow$	$(1-p)q$	0	0	0	0	0
Lose $\downarrow$	$(1-p)(1-q)$	0	0	0	0	0

- The expected consumption difference is: $p[qh+(1-q)(-l)]$.
- Terms a,b,c and d sum to: $p^2[qh+(1-q)(-l)](q(\lambda-1)+1)$.
- Terms c,d,e and f sum to: $p(1-p)[qh+(1-q)(-l)]$.

Let $\bar{g} = qh+(1-q)(-l)$, the expected return to holding the stock in the aftermarket. Summing these three pieces we have the condition:

$$\begin{aligned}
EU[\text{Follow Plan 3}|\text{Plan 3}] - EU[\text{Follow Plan 1}|\text{Plan 3}] &> 0 \\
\bar{g}(p + p^2(q(\lambda-1)+1) + p(1-p)) &> 0 \\
\bar{g}p(1 + p(q(\lambda-1)+1) + (1-p)) &> 0 \\
p\bar{g}(2 + pq(\lambda-1)) &> 0
\end{aligned}$$

Given our assumption that the stock has a positive expected return $\bar{g} > 0$, this condition will always be true, i.e., given that the agent plans to pursue Plan 3, they will not wish to deviate to Plan 1, which involves "never holding" or "always selling" the positive expected return stock.

C.3.2 Condition: No Deviation to Plan 2 Assuming Plan 3 is the Plan

We want to calculate $EU[\text{Follow Plan 3}|\text{Plan 3}] - EU[\text{Follow Plan 2}|\text{Plan 3}]$. Table C.3.2 already summarizes $EU[\text{Follow Plan 3}|\text{Plan 3}]$. We compute $EU[\text{Follow Plan 2}|\text{Plan 3}]$ below:

EU[Follow Plan 2| Plan 3]

	Probability	Consumption	Win ↑	Win ↓	Lose ↑	Lose ↓
Win ↑	pq	$s+x+h$	0	$p(1-q)(h+l)$	$(1-p)q(x+h)$	$(1-p)(1-q)(x+h)$
Win ↓	$p(1-q)$	$s+x-l$	$pq\lambda(-l-h)$	0	$(1-p)q(x-l)$	$(1-p)(1-q)(x-l)$
Lose ↑	$(1-p)q$	$s+h$	$pq\lambda(-x)$	$p(1-q)\lambda(-x+h+l)$	$(1-p)qh$	$(1-p)(1-q)h$
Lose ↓	$(1-p)(1-q)$	$s-l$	$pq\lambda(-l-x-h)$	$p(1-q)\lambda(-x)$	$(1-p)q\lambda(-l)$	$(1-p)(1-q)\lambda(-l)$

The table below shows $EU[\text{Follow Plan 3}|\text{Plan 3}] - EU[\text{Follow Plan 2}|\text{Plan 3}]$:

	Probability	Consumption	Win ↑	Win ↓	Lose ↑	Lose ↓
Win ↑	pq	0	0	0	0	0
Win ↓	$p(1-q)$	0	0	0	0	0
Lose ↑	$(1-p)q$	$-h$	$^{a}pq\lambda(-h)$	$^{b}p(1-q)\lambda(-h)$	$^{e}-(1-p)qh$	$^{f}-(1-p)(1-q)h$
Lose ↓	$(1-p)(1-q)$	l	$^{c}pq\lambda l$	$^{d}p(1-q)\lambda l$	$^{g}(1-p)q\lambda l$	$^{h}(1-p)(1-q)\lambda l$

- The expected consumption difference is: $(1-p)[q(-h)+(1-q)l] = (1-p)(-\bar{g})$.
- Terms a,b,c and d sum to: $(pq\lambda + p(1-q)\lambda)(1-p)(-\bar{g})$.

- Terms e,f,g and h sum to: $(1-p)^2(-\bar{g})+(1-p)^2(1-q)(\lambda-1)l$.

One useful observation here is that the only positive term in the three bullet points above is $(1-p)^2(1-q)(\lambda-1)l$. All the other terms are negative, which means that they provide incentive for the agent to want to deviate from Plan 3 to Plan 2. This positive term, however, is the only force causing the agent to stick to Plan 3 in this model. Intuitively, this positive term comes from mental comparison the agent does when they lose the lottery, choose to deviate to Plan 2, and the stock goes down. In this case, the agent loses utility because they had expected to stick with Plan 3 where they would not incur a loss if they lose the lottery and the stock goes down in the after-market. This term is the main reason why we can Plan 3 as a PE in this model.

Summing these three pieces we have the condition:

$$
\begin{aligned}
(1-p)\left((1+p\lambda+(1-p))(-\bar{g})-(1-p)(1-q)(1-\lambda)l\right)>0 \\
(1+p\lambda+(1-p))(-\bar{g}) &> (1-p)(1-q)(1-\lambda)l \\
(1+p\lambda+(1-p))q(-h) &> (1-q)[(1-p)(1-\lambda) \\
&\quad -1-p\lambda-1+p]l \\
(1+p\lambda+(1-p))q(-h) &> (1-q)(-\lambda-1)l \\
(1+p\lambda+(1-p))q(-h) &> (1-q)(1+\lambda)(-l)
\end{aligned}
$$

Note that with no loss-aversion ($\lambda=1$), the final equation simplifies to $0>\bar{g}$, which says that with no loss-aversion, the agent does not deviate from Plan 3 to Plan 2 only in the case where the expected return on the stock is less than zero. However, if that were true, the agent would deviate from Plan 3 to Plan 1 (as shown above). Taken together, if the agent has no loss-aversion, Plan 3 can never be a PE.

C.3.3 Understanding Our No-Deviation Conditions

We know that $\overline{g} > 0$ from the no-deviation condition for Plan 3 to Plan 1, which implies that $\frac{qh}{(1-q)l} > 1$. From the no-deviation condition from Plan 3 to Plan 2 we have $\frac{qh}{(1-q)l} < \frac{1+\lambda}{2+p(\lambda-1)}$. So for the agent to neither prefer to deviate to Plan 1 or Plan 2 we need the following inequalities to hold simultaneously:

$$1 < \frac{qh}{(1-q)l} < \frac{1+\lambda}{2+p(\lambda-1)} \tag{15}$$

We can interpret this condition as giving a range of what the expected return on the stock in the after-market has to be to make the agent to choose to follow through on Plan 3 versus deviating to the other plans. The expected return has to be bounded because if it is too low, the agent never wants to hold the stock, and would just prefer Plan 1. And if the return is too high, the agent will deviate from Plan 3 to Plan 2, where they hold the stock regardless of whether they win or lose the lottery. The figure shows that with the restrictive assumption that $h = l$, there is a relatively small range of q values for which the endowment effect plan is a PE.

As in the previous model, we once again check the two no-deviation conditions for a more general $h = kl$ setting. These are:

PE1:

$$p\bar{g}(2 + pq(\lambda - 1)) > 0$$

With $h = kl$, $\bar{g} = l(qk - (1-q))$. Substituting back into the PE condition, it is now:

$$p(qk - (1-q))(2 + pq(\lambda - 1)) > 0$$

PE2:

$$(1 + p\lambda + (1-p))q(-h) > (1-q)(1+\lambda)(-l)$$

This becomes:

$$(1 + p\lambda + (1-p))qk < (1-q)(1+\lambda)$$

We graph these two conditions below to find parameter ranges in which the endowment effect plan is a PE:

For relating these PE ranges to our data, the most interesting feature of this result is that as p approaches 1, there are fewer and fewer values of parameters q and k for which the endowment effect plan is a PE.

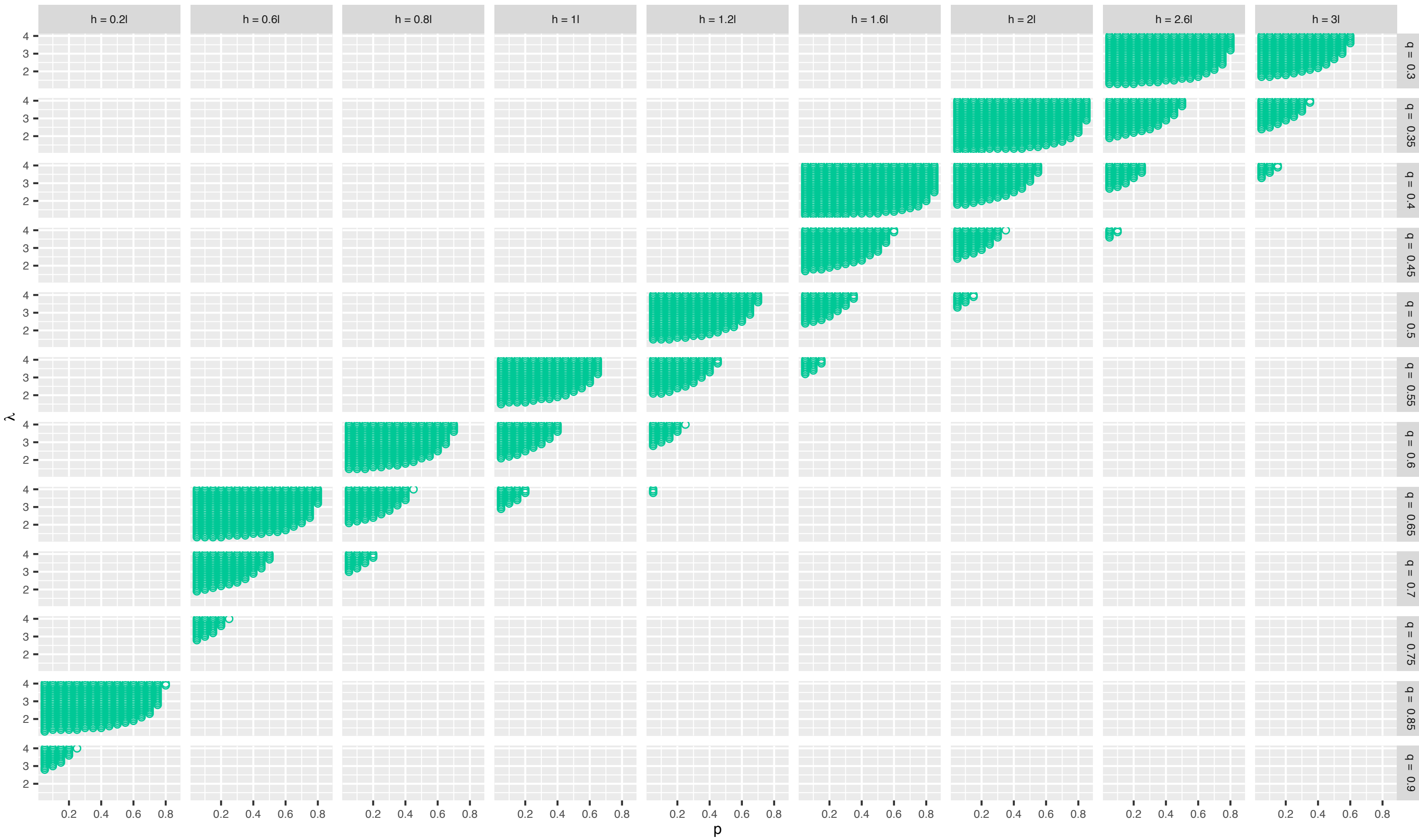
The intuition for this result is that when p gets close to 1 in this model the comparisons agents make across winning and losing the lottery become less and less important, because it is unlikely that they will lose the lottery. As the comparison across winning and losing gets less important, decision making depends more and more on the simple expected return of the stock, which pushes agents towards either Plan 1 (never hold) if the expected return is low, or Plan 2 (always hold) if the expected return is high.

Empirically, what this says is that when p gets close to 1 there should be a lower estimated endowment effect in the data. Looking at our empirical estimates of how the endowment effect varies with the probability of winning a given lottery (Table 6), when p rises, we find that the endowment effect goes down, but not by a very large amount. While the fact that the estimated endowment effect gets smaller as the probability of winning is consistent with this model in the full sample, it becomes less strong, and even reverses sign for the samples of frequent traders.

Now it is important that the predictions about variation along the dimension of p needs to be accompanied by equivalent variation along the q and k dimensions, and it is impossible to condition on these unobservable beliefs. However we can say that in order for the endowment effect to be a PE especially for those applicants in share categories with high probabilities of being allotted, they must have a particular type of belief about expected returns on the stock. They would need to either believe that there are high positive returns with low probability, or low positive returns with high probability. *These beliefs might not be very different from the observed empirical distribution of IPO returns over our sample which seem highly positively skewed (see plot).*

We have also gone further and derived the conditions necessary for Plan 3 (the endowment effect plan) to be a PPE, i.e. the (preferred) personal equilibrium with the highest expected utility. We find that the ranges of p and λ required to make Plan 3 a PPE are substantially smaller than those that deliver Plan 3 as a preferred equilibrium. In particular in the symmetric case of $h = l$, Plan 3 is not a PPE even in the case where p is close to 1 and q is exactly equal to 0.5. These results support the idea that Plan 3 is very unlikely to be a PPE for lotteries where p is close to 1. As noted in Kőszegi and Rabin (2006), the preferred personal equilibrium must naturally also be a personal equilibrium, otherwise the agent would have an incentive to deviate from their equilibrium choices, so for brevity we do not report those results here (available upon request).

Figure C.3.1: No Deviation Conditions, where $h = k \times l$



C.3.4 The Case of $l > x$

We now consider the case in which $l > x$, i.e., the potential loss on the stock, post-listing, on the day that it lists, is modelled as *larger* than the listing gain. We think of this assumption as describing the long run case in which the after-market losses from holding the stock could potentially be larger than the listing gain.

An agent in this model has the same four potential plans summarized in Table C.3.1. As before, Plan 3 is the "endowment effect plan." Once again, we omit consideration of Plan 4, the "anti-endowment effect" plan as it is not empirically relevant in our setting.

No-Deviation Condition from Plan 3 to Plan 1 $(l > x)$ We wish to calculate EU[Follow Plan 3|Plan 3] $-$ EU[Follow Plan 1|Plan 3].

EU[Follow Plan 3|Plan 3] can be represented in tabular form as:

EU[Follow Plan 3 | Plan 3]

	Probability	Consumption	Win ↑	Win ↓	Lose ↑	Lose ↓
Win ↑	pq	$s+x+h$	0	$p(1-q)(h+l)$	$(1-p)q(x+h)$	$(1-p)(1-q)(x+h)$
Win ↓	$p(1-q)$	$s+x-l$	$pq\lambda(-l-h)$	0	$(1-p)q\lambda(x-l)$	$(1-p)(1-q)\lambda(x-l)$
Lose ↑	$(1-p)q$	s	$pq\lambda(-x-h)$	$p(1-q)(-x+l)$	0	0
Lose ↓	$(1-p)(1-q)$	s	$pq\lambda(-x-h)$	$p(1-q)(-x+l)$	0	0

EU[Follow Plan 1|Plan 3]:

EU[Follow Plan 1 | Plan 3]

	Probability	Consumption	Win ↑	Win ↓	Lose ↑	Lose ↓
Win ↑	pq	$s+x$	$pq\lambda(-h)$	$p(1-q)l$	$(1-p)qx$	$(1-p)(1-q)x$
Win ↓	$p(1-q)$	$s+x$	$pq\lambda(-h)$	$p(1-q)l$	$(1-p)qx$	$(1-p)(1-q)x$
Lose ↑	$(1-p)q$	s	$pq\lambda(-x-h)$	$p(1-q)(-x+l)$	0	0
Lose ↓	$(1-p)(1-q)$	s	$pq\lambda(-x-h)$	$p(1-q)(-x+l)$	0	0

And finally, EU[Follow Plan 3|Plan 3] $-$ EU[Follow Plan 1|Plan 3]:

	Probability	Consumption	Win ↑	Win ↓	Lose ↑	Lose ↓
Win ↑	pq	h	[a] $pq\lambda h$	[b] $p(1-q)h$	[e] $(1-p)qh$	[f] $(1-p)(1-q)h$
Win ↓	$p(1-q)$	$-l$	[c] $pq\lambda(-l)$	[d] $-p(1-q)l$	[g] $(1-p)q((\lambda-1)x-\lambda l)$	[h] $(1-p)(1-q)((\lambda-1)x-\lambda l)$
Lose ↑	$(1-p)q$	0	0	0	0	0
Lose ↓	$(1-p)(1-q)$	0	0	0	0	0

- The expected consumption difference is: $p[qh+(1-q)(-l)]$.
- Terms a,b,c and d sum to: $p^2[qh+(1-q)(-l)](q(_{\lambda-1})+1)$
- Terms c,d,e and f sum to: $p(1-p)[\bar{g}+(1-q)(\lambda-1)(x-l)]$

Let $\bar{g} = qh+(1-q)(-l)$. Summing these three pieces we have the condition:

$$\begin{aligned}
EU[\text{Follow Plan 3}|\text{Plan 3}] - EU[\text{Follow Plan 1}|\text{Plan 3}] &> 0 \\
\bar{g}(p+p^2(q(\lambda-1)+1)+p(1-p))+p(1-p)(1-q)(\lambda-1)(x-l) &> 0 \\
\bar{g}(2+pq(\lambda-1))-(1-p)(1-q)(\lambda-1)(l-x) &> 0 \\
\bar{g} &> \frac{(1-p)(1-q)(\lambda-1)(l-x)}{2+pq(\lambda-1)}
\end{aligned}$$

With no loss-aversion ($\lambda = 1$),this condition simplifies to $\bar{g} > 0$; the agent will not deviate to Plan 1 as long as the expected return on the stock is greater than zero.

No-deviation Condition from Plan 3 to Plan 2 ($l > x$) We want to calculate EU[Follow Plan 3|Plan 3] $-$ EU[Follow Plan 2|Plan 3]. We already have the first piece in table form, now we need to calculate the second piece in table form.

EU[Follow Plan 2| Plan 3]

	Probability	Consumption	Win $\uparrow$	Win $\downarrow$	Lose $\uparrow$	Lose $\downarrow$
Win $\uparrow$	pq	$s+x+h$	0	$p(1-q)(h+l)$	$(1-p)q(x+h)$	$(1-p)(1-q)(x+h)$
Win $\downarrow$	$p(1-q)$	$s+x-l$	$pq\lambda(-l-h)$	0	$(1-p)q\lambda(x-l)$	$(1-p)(1-q)\lambda(x-l)$
Lose $\uparrow$	$(1-p)q$	$s+h$	$pq\lambda(-x)$	$p(1-q)(-x+h+l)$	$(1-p)qh$	$(1-p)(1-q)h$
Lose $\downarrow$	$(1-p)(1-q)$	$s-l$	$pq\lambda(-l-x-h)$	$p(1-q)\lambda(-x)$	$(1-p)q\lambda(-l)$	$(1-p)(1-q)\lambda(-l)$

The next table gives $EU[\text{Follow Plan 3}|\text{Plan 3}] - EU[\text{Follow Plan 3}|\text{Plan 2}]$.

	Probability	Consumption	Win $\uparrow$	Win $\downarrow$	Lose $\uparrow$	Lose $\downarrow$
Win $\uparrow$	pq	0	0	0	0	0
Win $\downarrow$	$p(1-q)$	0	0	0	0	0
Lose $\uparrow$	$(1-p)q$	$-h$	$^{a}pq\lambda(-h)$	$^{b}p(1-q)(-h)$	$^{e}-(1-p)qh$	$^{f}-(1-p)(1-q)h$
Lose $\downarrow$	$(1-p)(1-q)$	l	$^{c}pq\lambda l$	$^{d}p(1-q)(-x+(1-\lambda)l)$	$^{g}(1-p)q\lambda l$	$^{h}(1-p)(1-q)\lambda l$

- The expected consumption difference is: $(1-p)[q(-h)+(1-q)l] = (1-p)(-\bar{g})$.
- Terms a,b,c and d sum to: $(1-p)p[(-\bar{g})((\lambda-1)q+1)-(1-q)^2(x+\lambda)l]$
- Terms e,f,g and h sum to: $(1-p)^2(-\bar{g})+(1-p)^2(1-q)(1-\lambda)l$

Summing these three pieces we have the condition:

$$-\bar{g}+p[(\bar{g})((\lambda-1)q+1)-(1-q)^2(x+\lambda)l]+(1-p)(-\bar{g})+(1-p)(1-q)(1-\lambda)l > 0$$

$$(-\bar{g})(2-p)+(-\bar{g})p((\lambda-1)q+1))+p(1-q)^2(x+\lambda)(-l)+(1-p)(1-q)(\lambda-1)(-l) > 0$$

$$\frac{(1-q)(-l)[p(1-q)(x+\lambda)+(1-p)(\lambda-1)]}{2+pq(\lambda-1)} > \bar{g}$$

Note that with no loss-aversion ($\lambda = 1$) the last equation simplifies to $0 > \bar{g}$, which says that with no loss-aversion the agent chooses to not deviate only in the case where the expected return on the stock is less than zero. However, in that case, they would deviate from Plan 3 to Plan 1 (as shown above), so with no loss-aversion Plan 3 can never be a PE.

No-Deviation Conditions Summary ($l > x$) Combining the no-deviation conditions that guarantee that the investor will choose to follow through on Plan 3 instead of deviating to Plan 1 or Plan 3, we have:

$$\frac{(1-p)(1-q)(\lambda-1)(l-x)}{2+pq(\lambda-1)} < \bar{g} < \frac{(1-q)(-l)[p(1-q)(x+\lambda)+(1-p)(\lambda-1)]}{2+pq(\lambda-1)}$$

Given that $l > x$ in this case, we know that the left-hand-side of this inequality will be greater than zero. The right-hand-side of this inequality will always be less than zero. This implies that there is no possible value of $\bar{g}$ that will be able to satisfy both of these no-deviation conditions simultaneously.

C.4 Brief Discussion of Reference-Dependence Models

Overall, the conclusions from our analysis of the various reference dependence models is that there are parameter ranges within which we can use these models to rationalize our empirical results. The parameter values required for the endowment effect to appear as a PE require that agents believe that these stocks have either high probabilities of low payoffs or low probabilities of high payoffs.

However, the parameter values required for the endowment effect to be a PPE in our setting are quite restrictive, and the comparative statics predicted by the models in this class do not seem to match up closely to the observations in our field setting.

D Issue Price as the Reference Price (Weaver-Frederick Model)

The main idea of the framework of Weaver and Frederick (2012) applied to our setting is that investors may see trading at the market price of the stock as a bad deal because it seems worse to them than transacting at the issue price. This is a behavioral alternative to comparing their private valuation to the market price when deciding to trade, which would characterize the decision of a standard expected utility maximizing investor.

This model formalizes the intuition that some lottery losers, despite believing that the stock is worth more than the listing price ($s+x$), may nevertheless not purchase it because they feel transacting at that price is a "bad deal" relative to the issue price s. This channel operates despite the fact that as a lottery loser, they never had the opportunity to purchase the stock at the issue price.

The basic setup of the model inherits the features and notation of the models solved earlier in the appendix, with the following additions: Investor i has valuation v_i for the stock in the moment after it lists. A rational lottery winner would hold the stock if their private valuation $v_i > s+x$, and sell otherwise, and a rational lottery loser would buy the stock if their $v_i > s+x$, and not buy otherwise. However, when the agent in this model thinks about trading the stock, he compares the market price to a distorted valuation which is a function of v_i *and the issue price* s (the reference price in our setting). The distortion works as follows: If trading at v_i would create a loss relative to s, then the agent's distorted valuation is lower than their true valuation. In particular, Weaver and Frederick model the distorted valuation as a linear combination of the true valuation and the reference (issue) price:

$$v_i^b = \alpha_L s + (1-\alpha_L)v_i,$$

where we use v_i^b to denote the distorted valuation of the prospective *buyer*, α_L is a distortion parameter that is the weight the agent places on s when determining the distorted valuation.

Consider for example an IPO with issue price $s = 100$ and listing price $s+x = 120$. Consider a lottery loser whose true valuation of the stock $v_i = 130$. If this investor was a standard expected utility decision maker, she would be willing to buy the IPO stock at any price up to 130. However, in this model, buying at 130 would be perceived as a loss relative to $s = 100$. In the model, this would create a distorted valuation which is lower than v_i. Say the agent has $\alpha_L = 0.4$, then the investor's distorted valuation would be $v_i^b = (0.4)100 + (1-0.4)130 = 118$, and the investor would choose not to purchase the IPO at the listing price of 120.

Now consider the case in which the agent has a private valuation v_i such that transacting creates a *gain* relative to the issue price. In this case, the agent simply uses v_i when making decisions, i.e., there is no distortion. In the example above, a lottery loser with $v_i = 90$ will see buying as delivering a gain since $s = 100$, and therefore no distortion is applied to their valuation.[21]

Taken together, for lottery losers (prospective buyers) the distorted valuation function takes the

[21] Weaver and Frederick (2012) present a generalized model in their appendix where transactions at valuations that produce gains relative to the issue price also have a distortion parameter α_G.They note that all of their results go through as long as $\alpha_L > \alpha_G$, which is true for our results as well given that ours is an application of their basic model.

following form:

$$
\begin{aligned}
v_i^b &= \alpha_L s + (1-\alpha_L) v_i \text{ if } v_i > s \\
v_i^b &= v_i \text{ if } v_i \leq s
\end{aligned}
$$

Analogously, a lottery winner's (prospective sellers') distorted valuation function takes the form:

$$
\begin{aligned}
v_i^s &= v_i \text{ if } v_i > s \\
v_i^s &= \alpha_L s + (1-\alpha_L) v_i \text{ if } v_i \leq s
\end{aligned}
$$

If the lottery winner values the stock more than the issue price, then they see selling at their valuation as a gain, and there is no distortion. However, if they value the stock less than the issue price, then they view selling at their valuation as a loss relative to the issue price, and therefore have a distorted valuation. In particular, winners who value the stock less than the issue price will have a distorted valuation that is higher than their true valuation.

D.1 Issue Price as Reference Price, Positive Listing Gain ($x > 0$)

We begin by analyzing the model in the case in which there is a positive listing gain, i.e. $x > 0$. We first consider the case where an investor's valuation is greater than the listing price, $v_i > s + x$. For a lottery winner, $v_i^s = v_i > s$, so the investor always wishes to hold the stock as their valuation is undistorted in this case. On the other hand, a lottery loser will purchase the stock after it lists if

$$
v_i^b = \alpha_L s + (1-\alpha_L) v_i > s + x, \tag{16}
$$

since their valuation is distorted on the buy side (as $v_i > s$).

Re-arranging equation (16), lottery losers will only hold the stock if $v_i > \frac{s+x}{1-\alpha_L}$. As $x > 0$ and $\alpha_L \in (0,1]$, the right hand side is larger than $s + x$. Put differently, lottery losers require a higher valuation before they are interesting in purchasing the stock, compared to the valuation that lottery winners need to hold the stock, creating a divergence between the behavior of winners and losers.

The intuition for this result is that losers' valuations are anchored by the issue price, and this anchoring reduces their willingness to pay for the stock even if their true valuation of the stock is higher than the listing price. This difference in valuations implies there will be some lottery participants who would choose to hold the stock if they win the lottery, but would not choose to buy the stock if they lost the lottery – the endowment effect.

Next, consider the case where an investor's valuation is between the issue price and the listing price, $s < v_i < s + x$. In this case, all lottery winners choose to sell the stock because they value it less than the market price, and there is no distortion in their valuation because selling at these valuations constitutes a gain relative to the issue price. And, no lottery losers will choose to buy the stock because their distorted valuation ($v_i^b = \alpha_L s + (1 - \alpha_L)v_i$) is less than their true valuation (v_i), which is in turn less than the market price ($s + x$). So, in this case both winners and losers will both choose not to hold the stock, meaning that the model cannot generate an endowment effect.

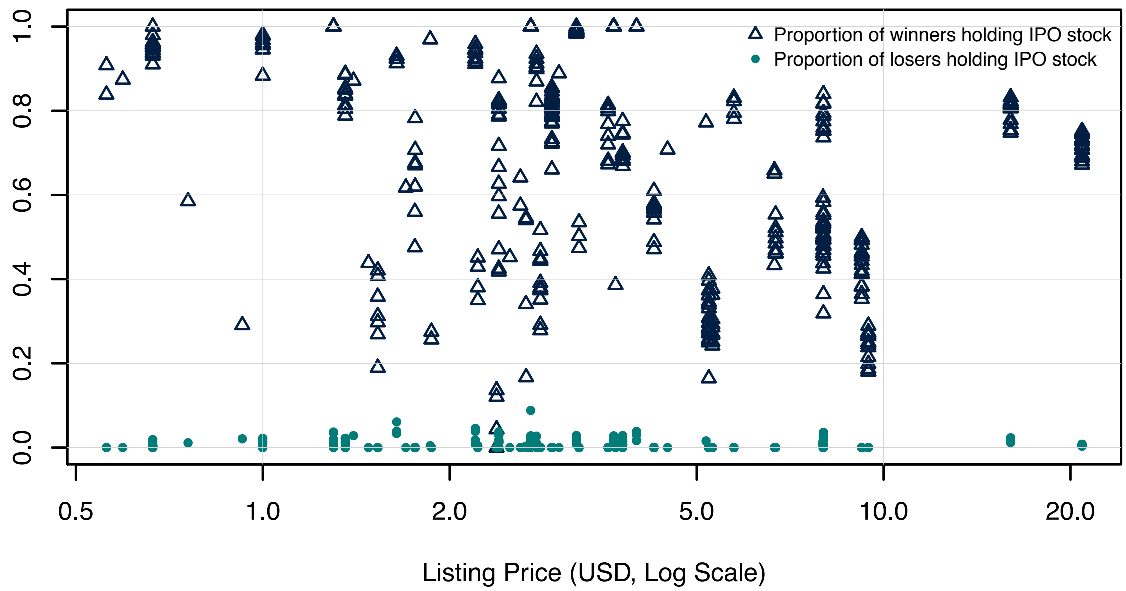
Finally, consider the case where the agent's valuation of the stock is less than the issue price ($v_i < s$). In this case, lottery losers will see buying at their valuation as a gain relative to the issue price, resulting in no distortion to their true valuation $v_i^b = v_i$. Given that $v_i < s < s + x$, these lottery losers never purchase the stock after it lists. Lottery winners, however, see transacting at their valuation as a loss relative to the issue price, so $v_i^s = \alpha_L s + (1 - \alpha_L)v_i > v_i$, i.e., their distorted valuation is greater than their true valuation because of their attachment to the reference price. Nonetheless, this distorted valuation is still always less than the listing price $s + x$ (because $x > 0$) and therefore all lottery winners will choose to sell. Thus, for lottery applicants with valuations lower than the listing price neither lottery winners nor losers will want to hold the stock after it lists, and once again, there is no endowment effect in this group.

Overall, if there is a positive listing gain, the model predicts that only those "optimistic" investors with valuations greater than the market price $(v_i > s + x)$ exhibit an endowment effect. In particular, the size of the endowment effect will be larger as the wedge between the cutoff valuations of lottery losers and lottery winners increases. Subtracting the lottery winners cutoff valuation from the lottery losers' valuation we get that the size of this wedge is $\frac{\alpha_L(s+x)}{1-\alpha_L}$. This expression shows that the wedge is increasing in the extent of loss aversion α_L.[22] However, as we do not observe individual investors degree of loss aversion directly, this prediction cannot be tested.

The expression also shows that the endowment effect is increasing in $s+x$, and in particular, in x, the size of the listing gain. As the listing gain increases, lottery losers' maximum buying prices get increasingly distorted by the fact that the issue price is more and more below the transaction price after listing. We can inspect whether this comparative static finds support in the data, i.e., if this model is to explain our evidence, we should see smaller endowment effects for IPOs with small listing gains, and larger endowment effects for IPOs with large listing gains.

In Figures 1a and 1b we find little relationship between the size of the listing gains and the endowment effect. More importantly, given that this model generates the endowment effect through a distorted valuation for lottery losers, we should see lottery losers being increasingly willing to buy the stock for small listing gains and increasingly unwilling to buy the stock for large listing gains. However, the first order fact here is that lottery losers do not increase their propensity to buy the stock when listing gains are low. In the paper, when we control for a host of IPO level covariates (which likely control for at least some of the underlying variation in loss aversion of investors across IPOs), we find a very small positive/negative relationship between the listing return and the size of the endowment effect.We also plot the endowment effect against the size of the total listing price $s+x$ in the figure below, and no relationship between the two is apparent as predicted by the model. The small relationship between listing gains and fraction of lottery losers who purchase the IPO stock also holds when we look at the more active trading samples in Figure 3.

[22]Note that when $\alpha_L = 0$ there is no endowment effect; loss aversion is necessary in this model to generate an endowment effect.



In Figure 4, however, we do see that the more active trading lottery losers are more likely to purchase the IPO stock when it has a lower return through the end of the first full month after listing. This result is consistent with the idea that lottery losers may be distorting their valuations downwards for stocks that had higher returns. However, it is clear from the figures that even for IPOs that experienced low returns, lottery winners are more likely to hold the stock than IPO losers.

D.2 Issue Price as Reference Price, Negative Listing Gain ($x < 0$)

We also consider the case where the listing gain is negative. We begin with investors whose valuations are less than the listing price ($v_i < s + x < s$). The lottery losers in this group view buying at their valuation as a gain, so $v_i^b = v_i$, and they will not purchase the stock because $v_i^b < s + x$. Lottery winners view selling at their valuation as a loss relative to the issue price, and therefore have distorted valuations $v_i^s = \alpha_L s + (1 - \alpha_L) v_i$. They hold the stock if $\alpha_L s + (1 - \alpha_L) v_i > s + x$, which simplifies to $v_i > s + \frac{x}{1-\alpha_L}$. Given that $x < 0$,there is a set of lottery winners with valuations that satisfy ($s + \frac{x}{1-\alpha_L} < v_i < s + x$) that choose to hold the stock. Once again, in this case, a "pessimistic" group of investors can generate an endowment effect when the listing gain is negative.

Consider the set of investors with valuations in the range $s+x < v_i < s$. The lottery losers in this group view buying at their valuation as a gain, so their distorted valuation is equal to their true valuation ($v_i^b = v_i$). All of these lottery losers will purchase the stock. Lottery winners view selling at their valuation as a loss relative to the issue price, and therefore, as in the case above, their valuations will be distorted upwards towards the issue price. Therefore, all of these lottery winners will also choose to hold the stock, and this set of investors does not produce an endowment effect.

Finally, consider investors with valuations $s+x < s < v_i$. Lottery losers will see buying at their valuation as a loss, and will have distorted valuations $v_i^b = \alpha_L s + (1-\alpha_L)v_i$. However, these distorted valuations are still always greater than $s+x$, so they always purchase the stock. Lottery winners see selling at their valuation as a gain relative to the issue price, and so there is no distortion and they all choose to hold the stock. There is no endowment effect in this case.

Similar to the case of the positive listing gain, we have here that the size of the endowment effect is a function of the listing gain and the loss-aversion weighting parameter. As x approaches zero from below, the size of the endowment effect should also approach zero. We only have two IPOs in our dataset that experienced negative listing returns, so we have limited ability to test this. Nevertheless, Figures 1a,1b and 3 show that for the two IPOs that had relatively small negative listing returns of -5 and -3 percent respectively, lottery winners are approximately between 45 and 65 percent more likely to hold the stock than lottery losers. Figure 4, however shows that lottery winners do seem less likely to sell the IPO stock as its return first full month becomes more negative. This result is consistent with these lottery winners having the issue price as a reference price, and being reluctant to sell. Similar to the case of the positive listing gain, we find some empirical evidence for the "aversion to bad deals" model in the longer run after the IPO. Note also that this model relies on optimistic investors to drive the endowment effect when listing gains are positive, and pessimistic investors to drive the effect when listing gains are negative – this potentially also generates additional testable implications in future studies which may be able to identify optimistic and pessimistic investors.

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