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.

*Anagol: Wharton School of Business, Business Economics and Public Policy Department, University of Pennsylvania, and Oxford-Man Institute of Quantitative Finance. Email: anagol@wharton.upenn.edu

†Balasubramaniam: Saïd Business School, Oxford-Man Institute of Quantitative Finance, University of Oxford, Park End Street, Oxford OX1 1HP, UK. Email: vimal.balasubramaniam@sbs.ox.ac.uk

‡Ramadorai: Saïd Business School, Oxford-Man Institute of Quantitative Finance, University of Oxford, Park End Street, Oxford OX1 1HP, UK and CEPR. Email: tarun.ramadorai@sbs.ox.ac.uk

Contents

For Online Publication Only

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

		Months Since Listing									
Dependent Variable:		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 ≤ 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 ≤ 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 ×				
# 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 ×				
# 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 ×				
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 ×				
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 ×				
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

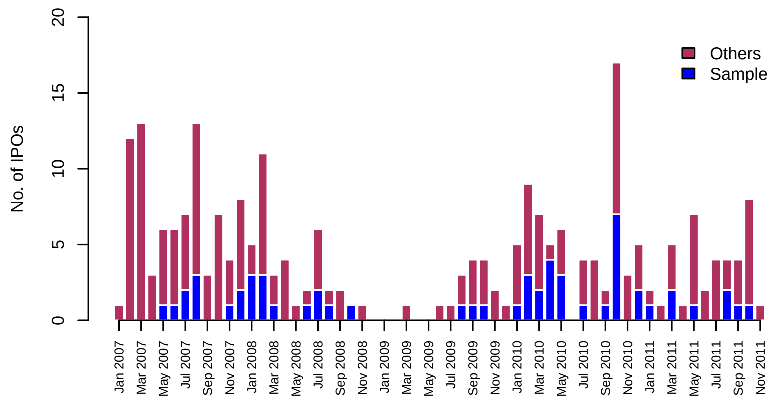


Figure A.1.2: Long-Run Holding Returns on IPOs in India

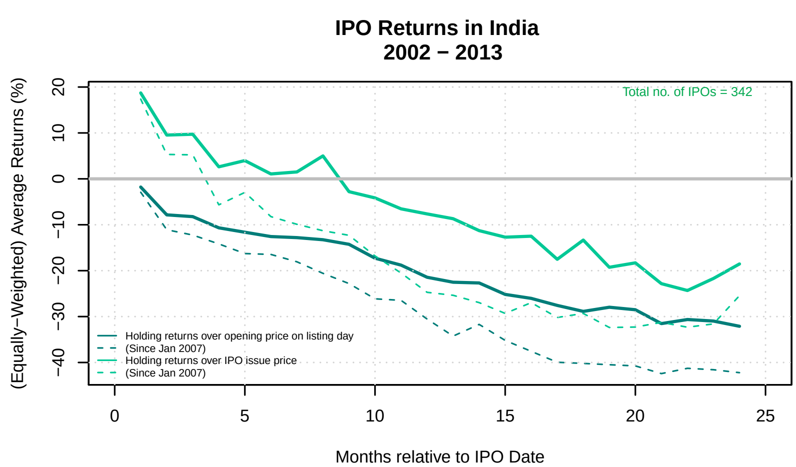
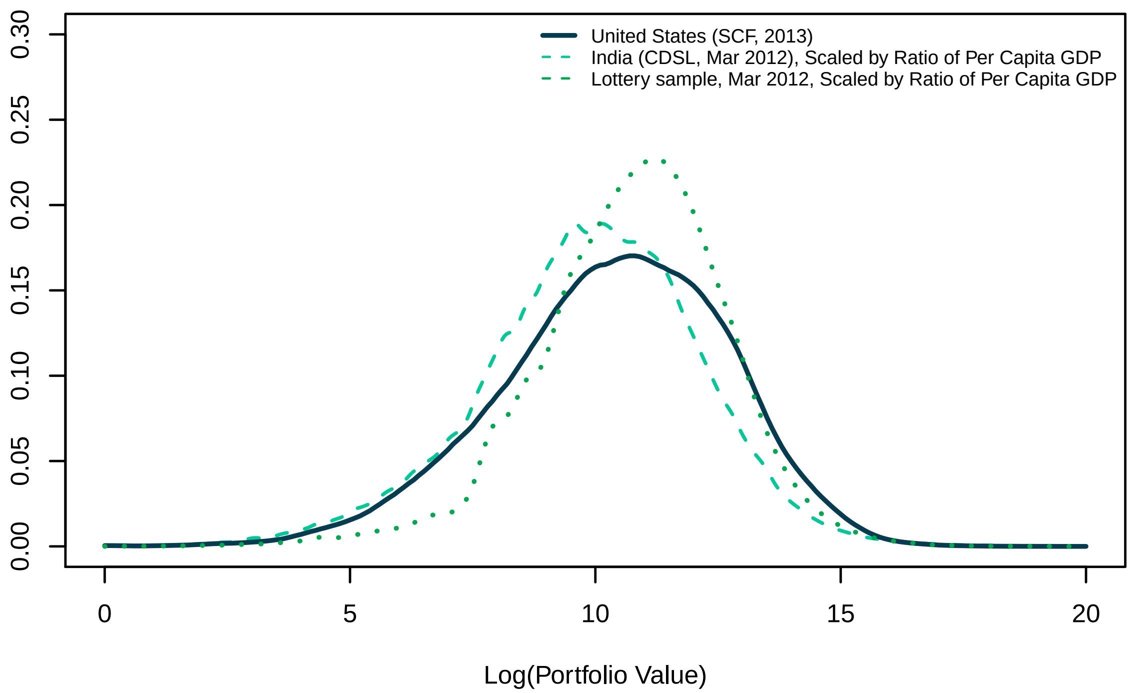


Figure A.1.3: Comparison of Lottery Sample to India and the United States

(a) Portfolio value distribution



(b) Histogram of number of trades

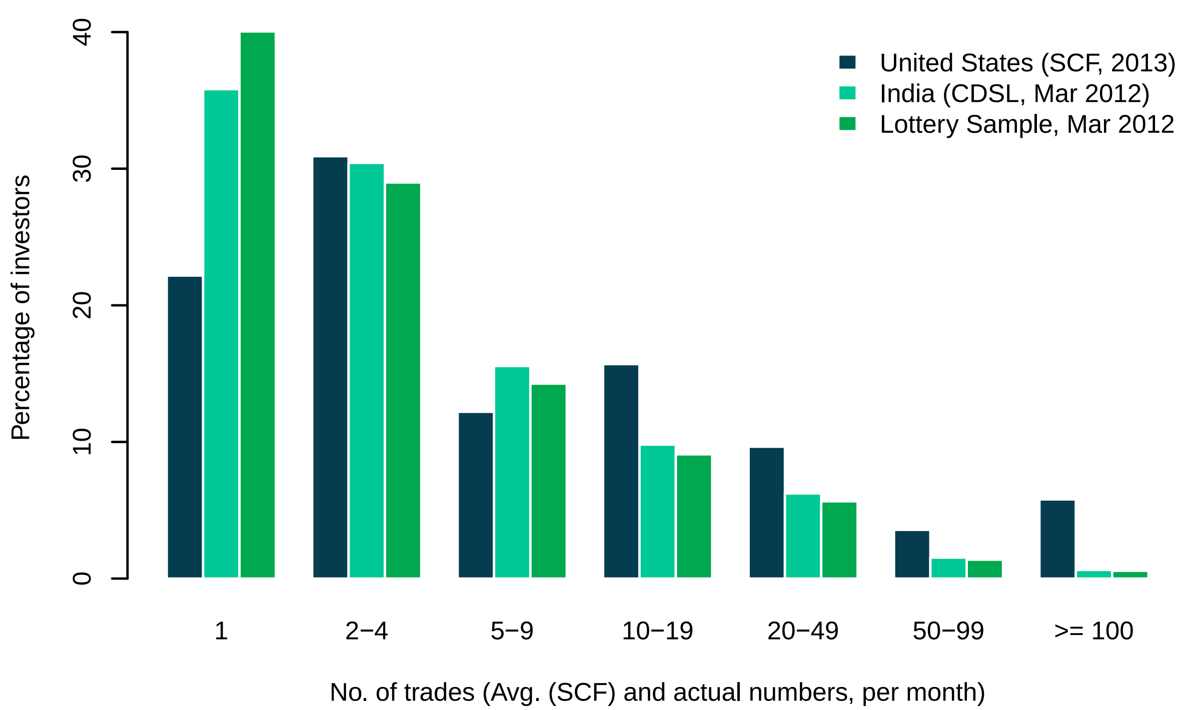


Figure A.1.4: Histogram of no. of investors with trade size $\leq$ allotment size

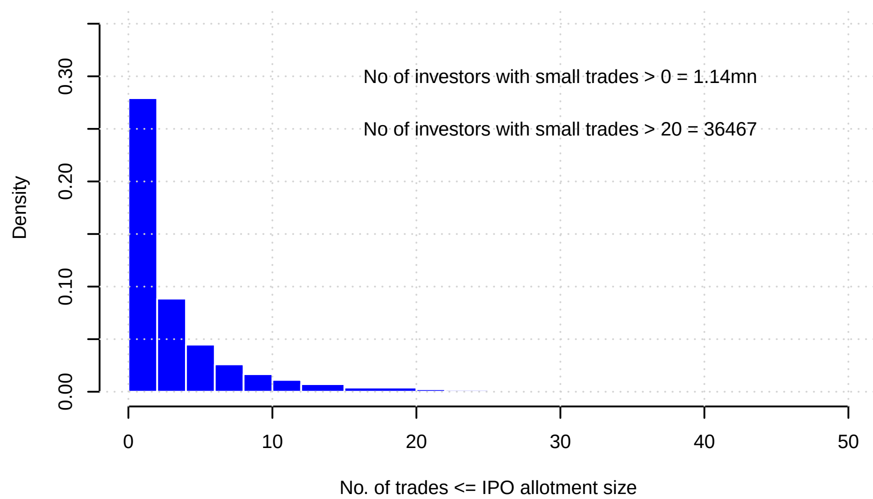


Figure A.1.5: Losers' Propensity to Buy in the IPO sector

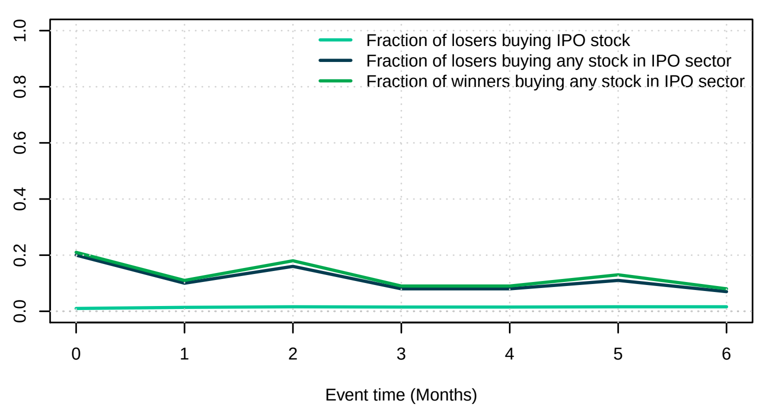


Figure A.1.6: Number of Securities Held (Including IPO Stock)

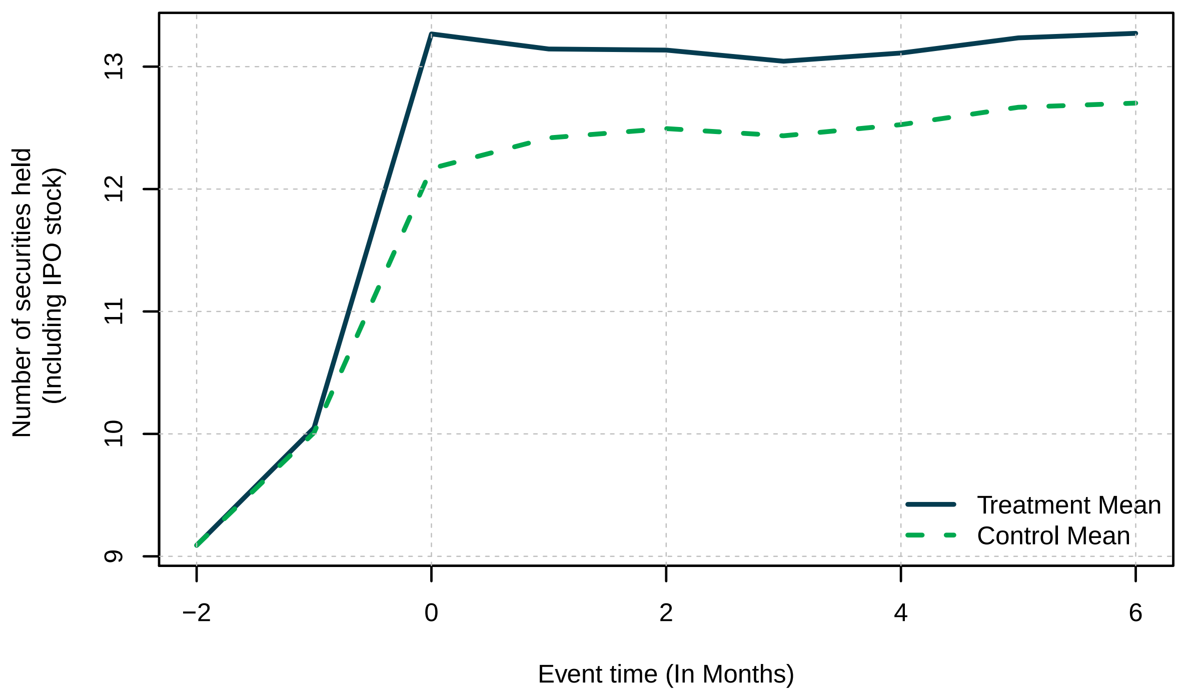
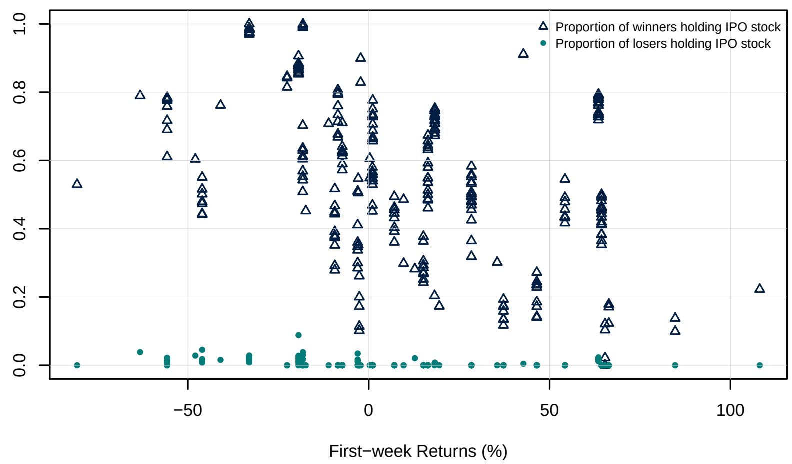
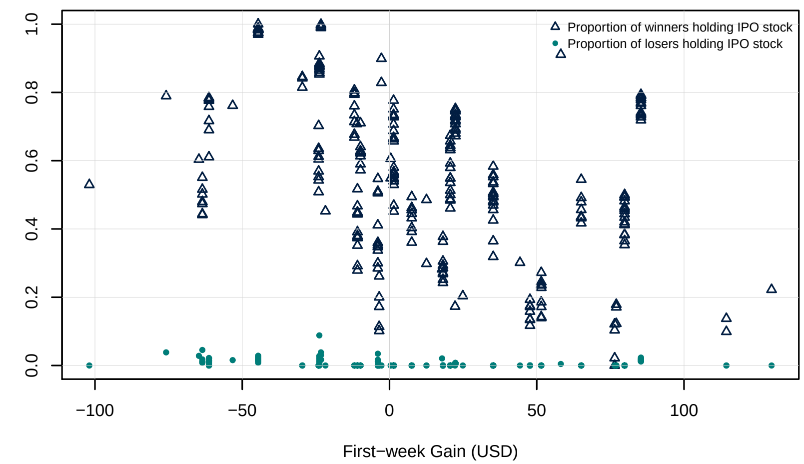


Figure A.1.7: Proportion of Investors Holding IPO Stock and Returns Experience: First-week after Listing

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



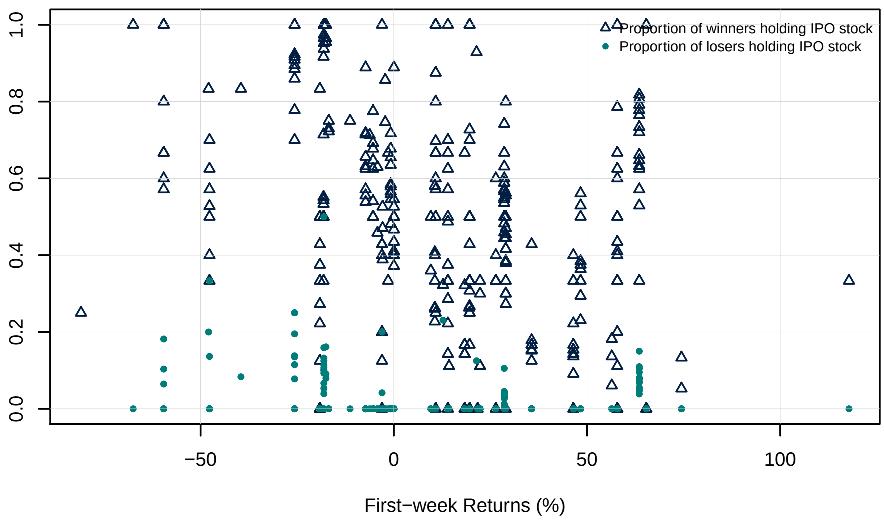
(b) Holding Gain at End of First Full Month After Listing (USD)



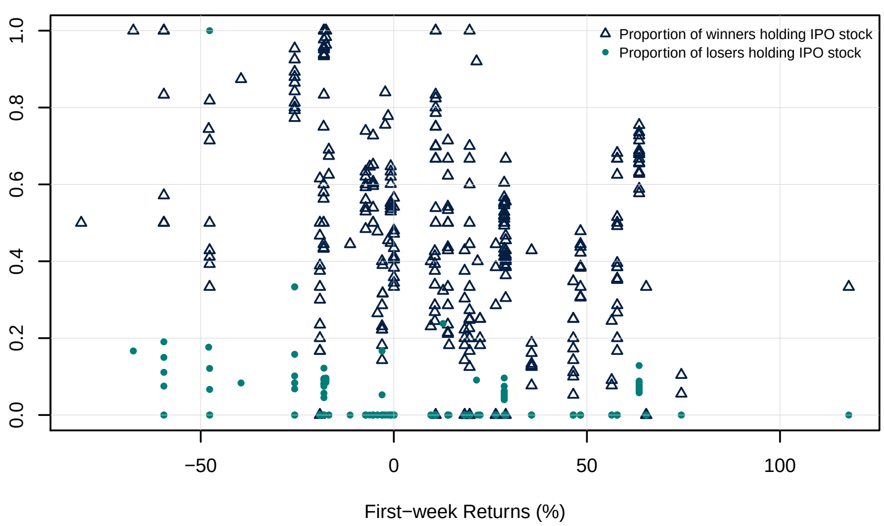
Panels (a) and (b) present estimates at the end of the first full week on the y-axis.

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

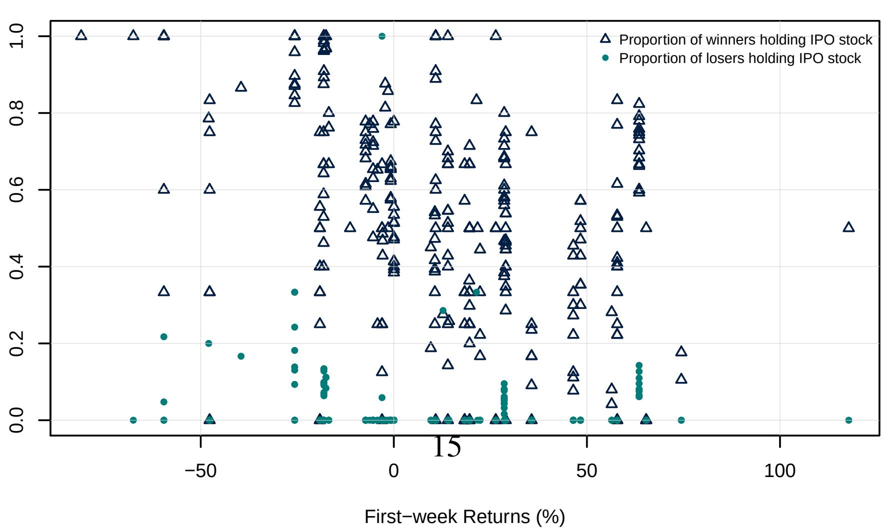
Panel A: Investors with > 20 trades per month on average in six months before lottery



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

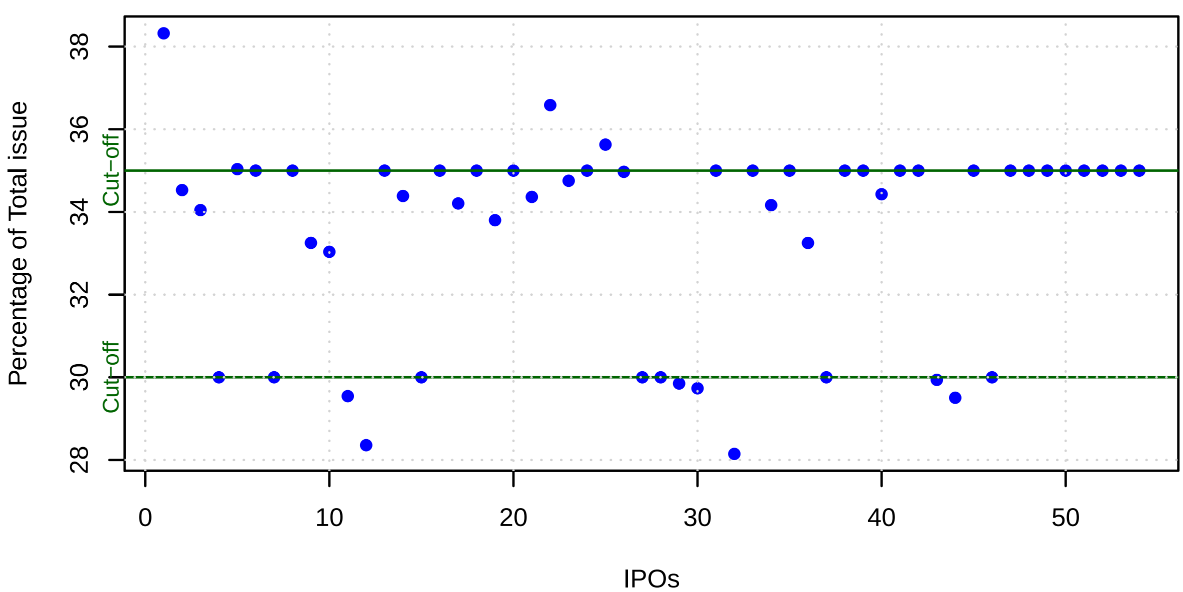
Let S be the total supply of shares that the firm decides to allocate to retail investors. Let $c = 1, \ldots, C$ index "share categories," which are integer multiples of the minimum lot size x for which investors can bid. The set of possible numbers of shares for which investors can bid is therefore: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

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

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.

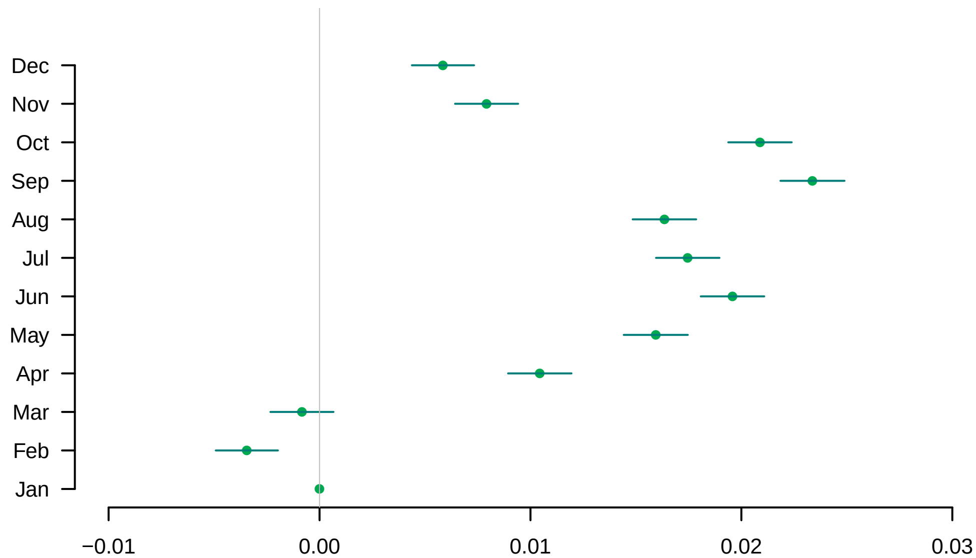
Tax Motivated Behavior. Two distinct tax issues might influence the holding behavior of lottery winners in the Indian context. First, the capital gains tax rate changes from 15 percent if a holding is sold within a year (a short term gain/loss) to zero if the holding is sold after one year. Investors 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:

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

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.

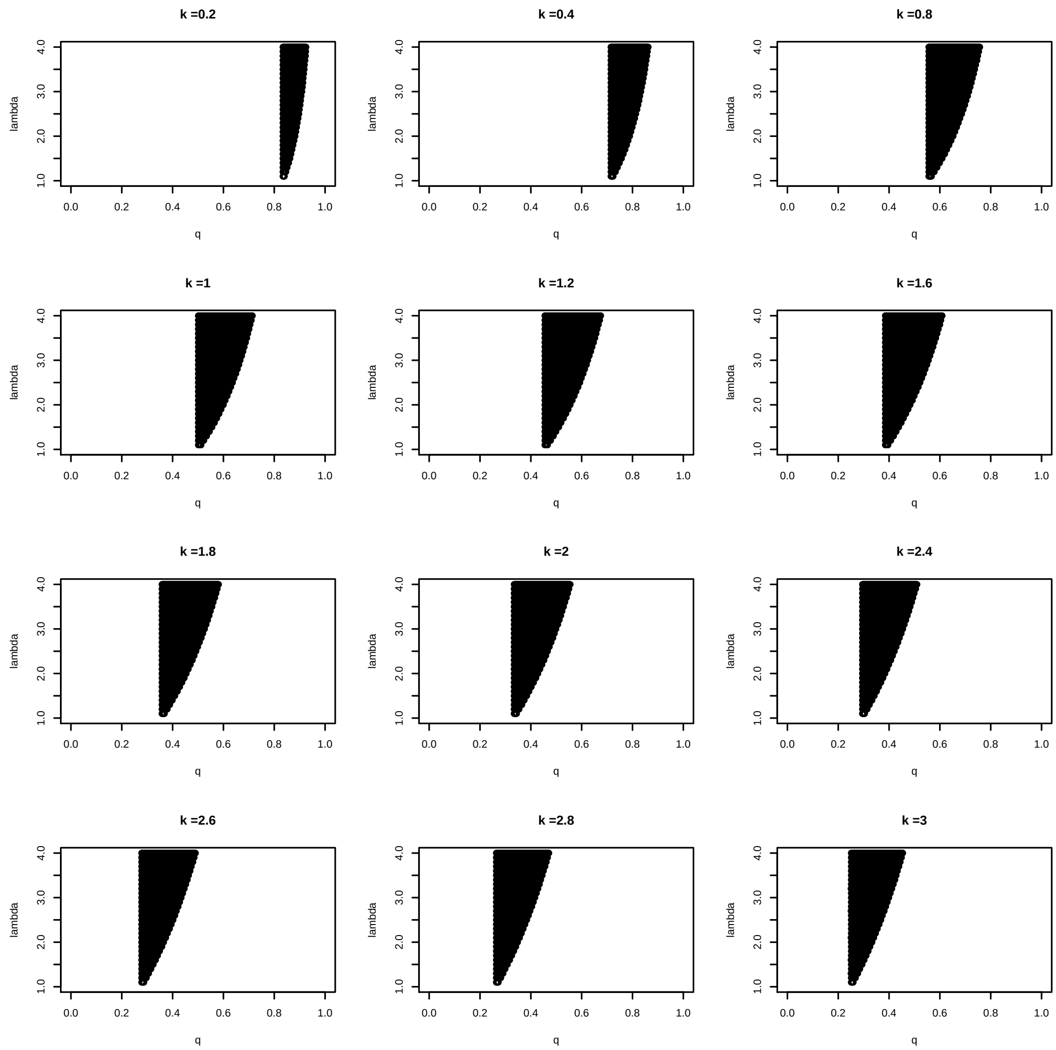
We therefore consider a more generalised version of the model, where gains can be proportional to losses, with factor of proportionality k, i.e., $h = kl$. In this case, the two no-deviation conditions become:

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

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

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:

$$EU(\text{plan to not buy}|\text{plan to not buy}) > EU(\text{buy stock}|\text{plan to buy}) \tag{11}$$

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

$$q(1-q)(\lambda-1)(h+l) > qh + (1-q)(-l) \tag{12}$$

For the lottery winner, the PPE condition is:

$$EU(\text{hold}|\text{plan to hold}) > EU(\text{sell} \mid \text{plan to sell}) \tag{13}$$

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

$$qh + (1-q)(-l) > q(1-q)(\lambda-1)(h+l) \tag{14}$$

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 $\uparrow$	Win $\downarrow$	Lose $\uparrow$	Lose $\downarrow$
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Plan 1 (Sell Stock if Win Lottery, Don't Buy Stock if Lose Lottery						
Win $\uparrow$	pq	$s+x$	0	0	$(1-p)q(x)$	$(1-p)(1-q)(x)$
Win $\downarrow$	$p(1-q)$	$s+x$	0	0	$(1-p)q(x)$	$(1-p)(1-q)(x)$
Lose $\uparrow$	$(1-p)q$	s	$pq\lambda(-x)$	$p(1-q)\lambda(-x)$	0	0
Lose $\downarrow$	$(1-p)(1-q)$	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 $\uparrow$	pq	$s+x+h$	0	$p(1-q)(h+l)$	$(1-p)q(x)$	$(1-p)(1-q)(x+h+l)$
Win $\downarrow$	$p(1-q)$	$s+x-l$	$pq\lambda(-l-h)$	0	$(1-p)q(x-l-h)$	$(1-p)(1-q)(x)$
Lose $\uparrow$	$(1-p)q$	$s+h$	$pq\lambda(-x)$	$p(1-q)\lambda(-x+h+l)$	0	$(1-p)(1-q)(h+l)$
Lose $\downarrow$	$(1-p)(1-q)$	$s-l$	$pq\lambda(-x-l-h)$	$p(1-q)\lambda(-x)$	$(1-p)q\lambda(-l-h)$	0
Panel C: Plan 3 (Hold Stock if Win Lottery, Don't Buy Stock if Lose Lottery						
Win $\uparrow$	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	$(1-p)q(x-l)$	$(1-p)(1-q)(x-l)$
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 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 $\uparrow$ and the agent compares this outcome to the ex-ante expectation that the state of the world would be Win $\uparrow$; 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 ↑	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	$pq\lambda(-x-h)$	$p(1-q)\lambda(-x+l)$	0	0
Lose ↓	$(1-p)(1-q)$	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 ↑	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 ↓	$p(1-q)$	$-l$	$^{c}pq\lambda(-l)$	$^{d}-p(1-q)l$	$^{g}(1-p)q(-l)$	$^{h}(1-p)(1-q)(-l)$
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: $p(1-p)[qh+(1-q)(-l)]$.

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.

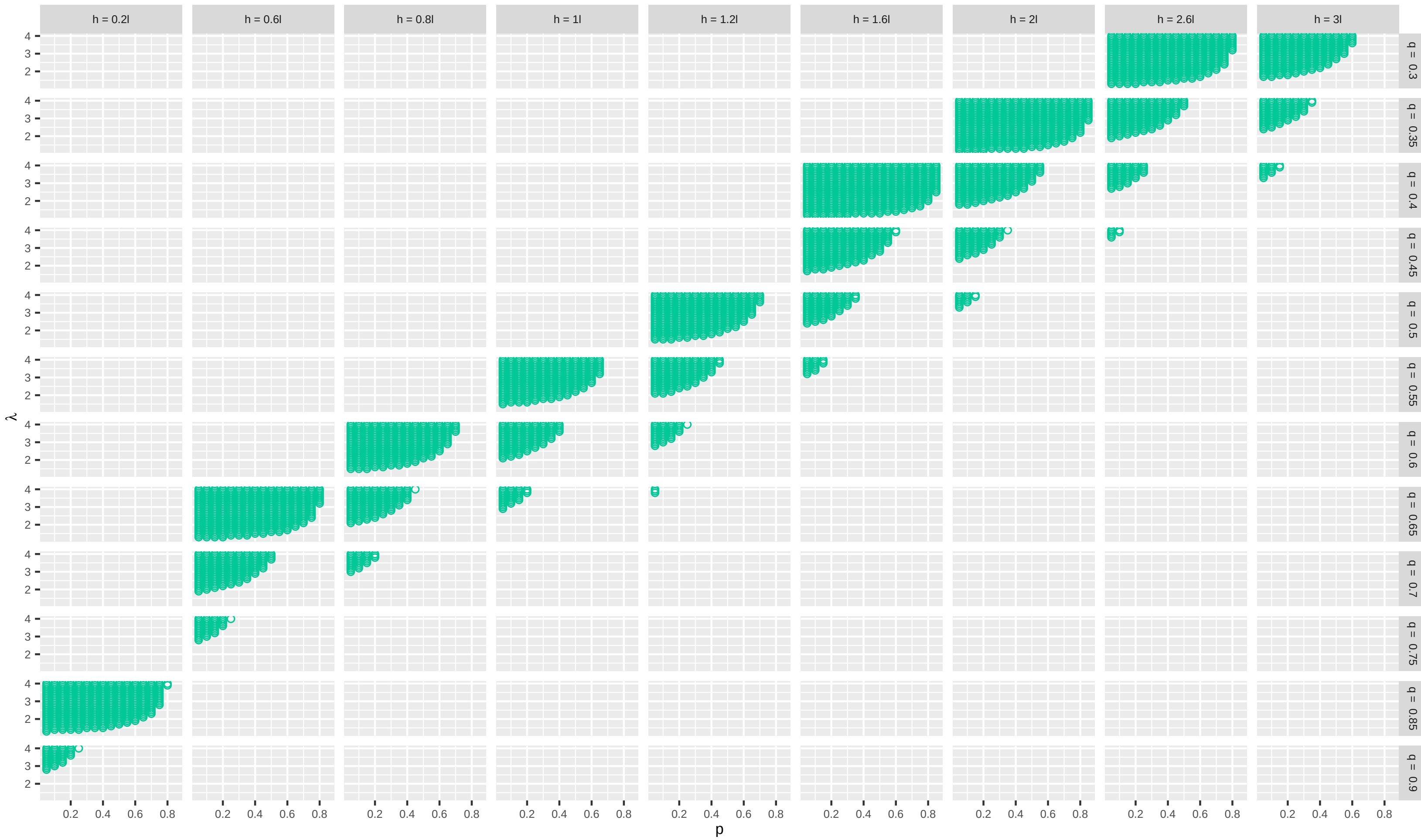
The intuition for this result is that when p gets close to 1 in this model the comparisons agents make across winning and losing the lottery become less and less important, because it is unlikely that they will lose the lottery. As the comparison across winning and losing gets less important, decision 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, $EU[\text{Follow Plan 3}|\text{Plan 3}] - EU[\text{Follow Plan 1}|\text{Plan 3}]$:

	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 $EU[\text{Follow Plan 3}|\text{Plan 3}] - EU[\text{Follow Plan 2}|\text{Plan 3}]$. 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.

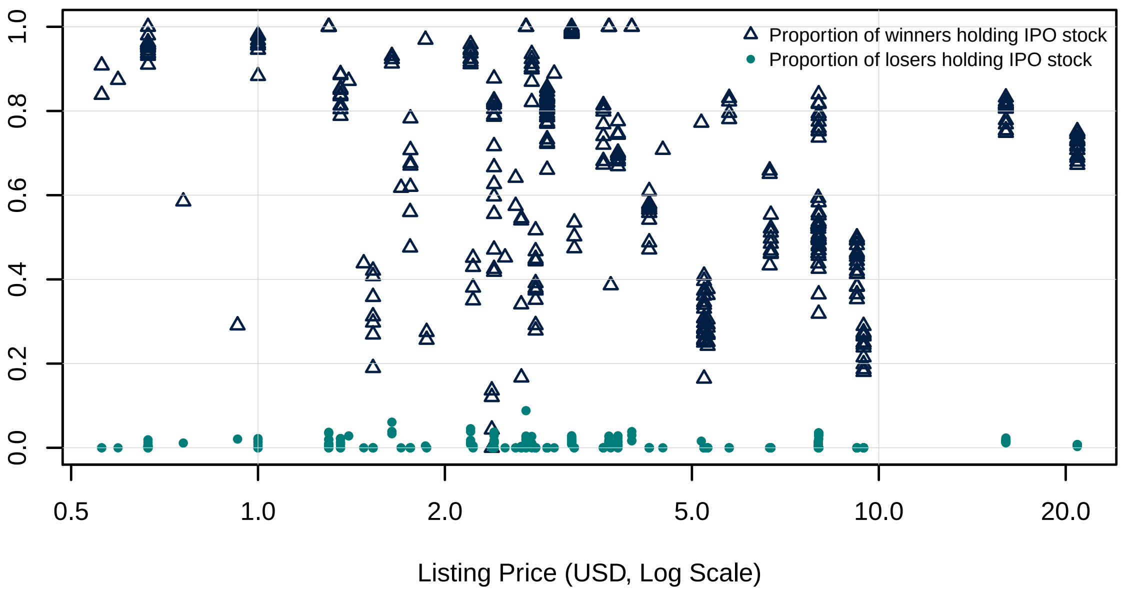
Finally, consider the case where the agent's valuation of the stock is less than the issue price ($v_i < s$). In this case, lottery losers will see buying at their valuation as a gain relative to the issue price, resulting in no distortion to their true valuation $v_i^b = v_i$. Given that $v_i < s < s+x$, 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.

References

Aggarwal, Reena, "Allocation of initial public offerings and flipping activity," *Journal of Financial Economics*, 2003, *68* (1), 111–135.

Anagol, Santosh, Vimal Balasubramaniam, and Tarun Ramadorai, "The Effects of Experience on Investor Behavior: Evidence from India's IPO Lotteries," *Available at SSRN 2568748*, 2015.

Constantinides, George M, "Optimal stock trading with personal taxes: Implications for prices and the abnormal January returns," *Journal of Financial Economics*, 1984, *13* (1), 65–89.

Ericson, Keith M Marzilli and Andreas Fuster, "Expectations as Endowments: Evidence on Reference-Dependent Preferences from Exchange and Valuation Experiments," *The Quarterly Journal of Economics*, 2011, *126* (4), 1879–1907.

Kőszegi, Botond and Matthew Rabin, "A model of reference-dependent preferences," *The Quarterly Journal of Economics*, 2006, pp. 1133–1165.

_ **and** _ , "Reference-dependent risk attitudes," *The American Economic Review*, 2007, pp. 1047–1073.

List, John A., "Does Market Experience Eliminate Market Anomalies?," *Quarterly Journal of Economics*, 2003, *118* (1), 41–71.

_ , "Does Market Experience Eliminate Market Anomalies? The Case of Exogenous Market Experience," *The American Economic Review*, 2011, *101* (3), 313–317.

Mohanty, Nirmal, "Cost of Trading in Stock Exchanges: A Perspective," *National Stock Exchange (NSE) Working Paper*, 2011.

Sprenger, Charles, "An endowment effect for risk: Experimental tests of stochastic reference points," *Journal of Political Economy*, 2015, *123* (6), 1456–1499.

Thaler, Richard H and Eric J Johnson, "Gambling with the house money and trying to break even: The effects of prior outcomes on risky choice," *Management science*, 1990, *36* (6), 643–660.

Weaver, Ray and Shane Frederick, "A reference price theory of the endowment effect," *Journal of Marketing Research*, 2012, *49* (5), 696–707.