ANCHORING AND HOUSING CHOICE:
RESULTS OF A NATURAL POLICY EXPERIMENT

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ABSTRACT

This research employs data from a natural experiment to assess the effects of behavioral heuristics on management of public programs. The analysis focuses on programs designed to privatize public housing in Israel. The programs provided tenants with a call (real) option to purchase their rental unit at a discounted exercise price. We employ a large panel of transactions over the 1999-2008 period to evaluate whether tenants used prior program price discounts as anchors in their purchase decisions. Results of hazard model estimation provide strong evidence of anchoring in timing of home purchase. Further, model simulation suggests that by accounting for the anchoring heuristic, program managers could both have accelerated purchases and significantly increased revenues associated with the privatization programs. We also find evidence that anchoring varies with individual and market characteristics.

Key Words: public economics, household behavior, anchoring, housing

Current Version: April 9, 2013

JEL Codes: D03, C9, R38

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1. INTRODUCTION

Anomalies in household economic behavior long have been the subject of theoretical inquiry and experimental analysis. Seminal work by Tversky and Kahneman (1974), for example, suggested that people tend to excessively focus on a specific piece of information and use it as an *anchor* for future decisions. [1] Experimental findings by Kahneman and Knetsch (1993), Ariely *et. al.* (2003) and others provide support for the anchoring hypothesis. Despite the preponderance of laboratory findings, few studies have applied empirical data to demonstrate the importance of heuristics to household decisions or to program management.[2]

Over the past decade, the Israeli government sought to privatize public housing via an offer to sell rental units to tenants at a discount from the market price. The discounts were based on tenant socio-demographic characteristics and changed over time. Tenants had the opportunity to either accept or decline successive government sales offers. Our research employs survival analysis to empirically assess whether public housing tenants used prior price reductions as anchors (or reference prices) in the purchase decision. [3]

We specify two statistical tests to assess the role of anchoring heuristics. In the first test, we use survival analysis to estimate whether the average of the past price

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[1]Several definitions of the anchoring heuristic are provided in the literature (see, for example, Chapman and Johnson [2002]). Tversky and Kahneman (1974) state that "In many situations, people make estimates by starting from initial value that is adjusted to yield the final answer. The initial value, or starting point, may be suggested by the formulation of the problem, or it may be a result of partial computation. In either case, adjustments are typically insufficient. That is, different starting points yield different estimates, which are biased toward the initial values. We call this phenomenon anchoring." (page 1128). Our research is further relevant to a growing literature that studies whether an uninformative *number* (the anchor) influences the judgment of the decision-makers (see, among many others, Tversky and Kahneman and [1974], Chapman and Johnson [1994], Strack and Mussweiler [1997], and Wansink, Kent and Hoch 1998]).

[2] The experimental methodology often employed by psychologists to examine heuristics suffers from many shortfalls, including concerns as to whether (1) behavioral patterns observed under artificial laboratory conditions are replicated in real-life decision-making (see, for example, List [2003], Levitt and List [2007, 2008] and DellaVigna [2009]); (2) conclusions drawn from laboratory experiments regarding individuals' consistency of preferences are reliable (see, for example, Knetsch, [1989, 1992]); and (3) laboratory conditions are appropriate, given that subjects often are offered limited possibilities and relatively low incentives to cooperate and, generally, are not "punished" for incorrect decisions.

[3] Following Tversky and Kahneman (1974), we use the terms "anchoring" and "anchor" throughout the paper [see also Ariely *et. al.* (2003)]. An alternative and equivalent terminology is "reference price" in the cases where the anchor refers to the monetary price of a product [e.g., Ariely and Simonson (2003), Bajari and Hortacsu (2003), Kamins *et. al.*(2004), Stern and Stafford (2006), Hoppe and Sadrieh (2007)].

reduction rates anchored the tenant's reaction to the current reduction rate. In so doing, we also stratify the sample and assess the heterogeneity of results to periods when the anchor is descending or ascending in value.[4]

We then use outcomes of the survival analysis to estimate purchase outcomes under simulated price reduction schemes. This allows us to assess the superiority of one scheme over another and to evaluate whether program managers could have increased revenues by explicitly accounting for the buyer "reference discount effect" in determination of the price reduction algorithm. Finally, we examine the sensitivity of the estimated anchoring effects to such features as age of household head, household income, and percentage of public housing units in the structure.[5]

Results provide strong evidence of anchoring in home purchase decisions. Estimated tenant responses to the anchor are significantly different from zero. Further, the hazard rate associated with purchase option exercise decreases 8 percent for every 1 percent increase in the anchor when the anchor is greater than the current reduction rate. In contrast, when the anchor is smaller than the current reduction rate, a 1 percent increase in the anchor leads to a significant 0.67 percent increase in the hazard rate. As shown in model simulation, by employing a descending pattern of price reduction rates, program managers could both have significantly accelerated the sale of public housing units and substantially reduced the discount offered to consumers at the time of purchase option exercise. Finally, as anticipated, results indicate that the estimated anchoring effect varies with prices and characteristics of home purchasers.

The contribution of the research is two-fold. First, our evidence on the role of the anchoring heuristic derives not from the laboratory but rather from a unique, real-world natural policy experiment. In that regard, our sampled households face decisions that involve substantial financial resources and have important long-term

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[4] Reduction rate schemes were calculated for each household separately based on the guidelines of the Israel Ministry of Housing and Construction. A simple statistical test supports the conclusion that households knew of and responded to their reduction rate scheme: the coefficient of $RED_{i,t}$, the current reduction rate measured in percentage points for tenant *i* at time *t*, was found to be positive and highly significant (see further details below).

[5] Here the analysis is motivated, in part, by studies by Genesove and Mayer (2001) and List (2003, 2004), who examine the effect of experience on heuristics. List (2003, 2004) demonstrates, as anticipated from rational expectations theory, that unlike inexperienced actors, experienced card collectors exhibit no status-quo bias.

personal consequences. Second, our analysis demonstrates a simple, practical, and direct application of cognitive biases to program management. It shows how government managers could use the estimated anchoring effect to more efficiently attain programmatic objectives. To the best of our knowledge, this paper is the first to examine the role of heuristics in a public program context.[6]

The plan of the paper is as follows. The following section provides background and literature review. Section 3 describes the data, including variable definitions and related summary statistics. Section 4 presents the empirical model while Section 5 provides related estimation results in support of anchoring effects. Section 6 describes simulation of alternative reduction rate schemes and demonstrates practical implications of the anchoring heuristic in assessment of management of public program design. Section 7 assesses the robustness of results to model specification whereas Section 8 evaluates the sensitivity of anchoring findings to individual interactive terms. Finally, section 9 provides summary and concluding remarks.

2. BACKGROUND

The majority of evidence in support of the anchoring heuristic derives from experimental settings. That literature covers a range of applications, notably including papers by Plous (1989), Wright and Anderson (1989), and Yamagishi (1994) in the estimation of risk and uncertainty; Johnson and Schkade (1989), Carlson (1990), and Chapman and Johnson (1994) in the evaluation of monetary lotteries; Cervone and Peake (1986) in assessment of self-efficacy; Davis *et al*. (1986) in judgments of spousal preferences; Chapman and Bornstein (1996) and Englich and Musswieler (2001) in jurors' decision-making; Dodonova and Khoroshilov (2004) in online auctions; Joyce and Biddle (1981) and Butler (1986) in financial auditing; and Ariely *et. al.* (2003) in coping with disturbing noises.[7] All of these laboratory experiment-based studies compare behaviors among groups of subjects exposed to

[6] Also, unlike most tenure choice studies, public housing tenants may either purchase or continue to rent the identical housing unit—hence, the tenure choice pertains to the same property. In contrast, studies dealing with movers from one location to another (e.g., Simonsohn and Loewenstein (2006)), largely do not control for variations in the structural features of the dwellings in question.

[7] For a thorough review of the literature on anchoring and other behavioral anomalies see, for example, Chapman and Johnson (2002) and DellaVigna (2009).

different single anchors. With the exception of Ariely *et. al.* (2003), none of them, however, refer to a series of successive anchors.

In contrast to experimental literature, empirical analyses (including field experiments) of behavioral anomalies are less prevalent. Accordingly, the literature contains only a few empirical studies focusing exclusively on anchoring. Relevant examples include studies of endowment effects among card collectors [List (2003, 2004)]; sales programs for sanitation and health products in Zambia and Kenya [Ashraf, Berry and Shapiro (2010) and Dupas (2010)]; and the impact of the seller's reservation price on final price in online internet bid auctions [see Ariely and Simonson (2003), Bajari and Hortacsu (2003), Kamins *et. al.* (2004), Stern and Stafford (2006), Hoppe and Sadrieh (2007) and Trautmann and Traxler (2010)].

In the housing literature, only a few empirical studies have examined behavioral anomalies. Of those, only Simonsohn and Loewenstein (2006) focus exclusively on the anchoring heuristic. As would be expected, anchoring appears to be important to real estate appraisal and to seller asking prices.[8] Genesove and Mayer (2001) and Anenberg (2010) show that loss aversion affects condominium asking prices, in that the price paid to purchase the unit serves to subsequently anchor the re-sale price. Finally, Simonsohn and Loewenstein (2006) demonstrate the importance of anchoring to rental housing consumption among movers. They suggest that rental rates in the prior location serve as anchors for movers to new locations.

In the wake of the recent severe boom-bust cycle in housing, the efficacy of government interventions and related housing assistance programs is of broad concern. DiPasqaule, Fricke, and Garcia-Diaz (2003) review and assess U.S. federal housing assistance programs. However, we are unaware of any study other than our own that indicates the importance of heuristics to housing program management. Further, in many countries, notably including the U.K., China, and Eastern Europe, major programs have been launched to privatize the substantial stock of public housing. Below we apply the real options approach to assess the role of the anchoring heuristic in the design and management of Israeli programs to privatize public housing.

[8] See, for example, Northcraft and Neale (1987).

3. A DESCRIPTION OF THE SAMPLE

We apply data from a recent Israeli government program to assess the role of anchoring in housing tenure choice. The data span the 1999 – 2008 period and include six consecutive sales programs intended to incent residents of public housing to purchase their dwelling unit.[9] The programs can be described as call (real) options that allow tenants to purchase their public rental units within a given timeframe and at a specified exercise price (set as a function of the market price net of a specified programmatic price reduction – see further details below). Each program provides an opportunity to assess resident behavioral response to a specified incentive structure. Unlike much of the empirical literature, the panel nature of our data allows us to examine resident response to successive program incentives, controlling for household socio-economic and demographic as well as market characteristics.

Data for the analysis were obtained from Amidar Ltd., the largest public housing corporation in Israel. The raw sample includes the universe of dwelling units managed by Amidar [total of 58,665 units – approximately half of the total public housing stock in Israel – see Bar Dadon (2000) for further details], of which 16,213 were purchased during 1999–2008. From the raw sample we generate an unbalanced panel of 6,853 public housing tenants who exercised the purchase option.[10] We assess the response of tenants to varying price reduction rates over a period of up to 114 months. The panel structure enables us to employ survival analysis to predict the proportion of households that exercise the purchase option in each period as well as the time duration until tenant option exercise. In this context, tenants fail to survive (failure=1) and are excluded from the sample at the time of their switch from renter to owner status.[11]

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[9] Note that as of September 2008, the sixth sale program was no longer valid. Subsequently, the privatization programs were discontinued.

[10] Observations omitted from the sample include cases of missing information regarding rent payments, more than 5 percent mismatch between the calculated reduction rate and the current reduction rate at the date of purchase, and tenants who entered the sample after t=0. Outcomes derived from this sample were found to be robust to those obtained while using the full sample containing both purchasers and non-purchasers. We are grateful to the assistance of Ronit Gerafi from Amidar LTD for providing us with detailed information regarding the calculation of the price reduction rates and to Smadar Shatz for her invaluable assistance in computation of the reduction rates for each tenant across periods.

[11] Two reasons justify our monthly perspective approach as opposed to the alternative, namely an unbalanced panel of six sale programs: 1) the latter does not weight the very dissimilar length of the different sale programs in months; 2) reduction rates may vary during the period of each sales program due to variations in the socio-demographic characteristics, such as the birth of a new child. In such cases, the latter data structure imposes information loss. Also, a major advantage of our dataset is the

Table 1A provides summary statistics on the cross-section of buyers at the date of home purchase option exercise. As indicated in the table, the average appraised value (before price discount) of the purchased housing units (*APPT_VALUE*) at the purchase date was $89,509 with a standard deviation of $29,387.[12] In comparison, units of similar size transacted at about twice that price in the private sector.[13] Table 1A further indicates an average rate of price discount of those units from appraised value at the date of purchase ($RED_{i,t}$) was 78 percent. As is evident, public housing tenants exercised the purchase option at deeply discounted values.

Table 1A further provides information on $ANCHOR_{i,t}$, the mean of all prior (t-1) reduction rates for tenant *i* at the date of purchase.[14] As is evident, the average of $ANCHOR_{i,t}$ was 53 percent with a standard deviation of 22 percent. These figures imply that the purchase option typically was exercised following an additional 25 percent discount over past mean reduction rate.

Table 1B presents summary statistics for the sample panel across all time periods (excluding the date of purchase). Note that the sample panel exhibits both a lower average price reduction rate ($RED_{i,t}$) of 45 percent and a lower $ANCHOR_{i,t}$ of 37 percent. The table further shows stratification of the sample into periods where the difference $RED_{i,t} - ANCHOR_{i,t}$ is negative (*NEG*=1 and zero otherwise); periods

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fact that the reduction rates offered to tenants are determined exogenously by the government. The reduction rates are calculated based on personal economic and socio-demographic characteristics as-well-as locational characteristics of the unit. Consequently, there is no endogeneity problem between the survival time until the exercise of the purchase option and the reduction rates offered to tenants over time.

[12] Referring to the unbalanced panel, *APPT_VALUE* has been computed across all time-periods based on the value of the housing unit at the date of purchase deflated backward for each survival time. Deflation is based on housing price indices of average transaction prices for 9 statistical regions published by the Israel Central Bureau of Statistics. For the convenience of the reader, all the variables measured in *NIS* (Israeli local currency) are converted to dollars, where 1 *NIS* roughly equals $0.25.

[13]Compared to the average value of a 3.18 room public housing units, the non-quality adjusted mean value of a transacted housing unit in the private market was 171,450 dollars with a standard deviation of 12,150 dollars.

[14] It should be noted in this context that the anchor that best fits the model is the mean of all prior reduction rates for tenant *i* at time *t*. Other anchors that were considered include: the initial, mean, and maximum current price reduction rate of tenant *i* and all tenants at time *t*. Also, under the current data structure of up to 114 months, the mean of all prior (*t*-1) reduction rates has two major advantages: 1) it preserves the memory of all prior reduction rates; and 2) it accounts as well for reduction rate volatility by weighting duration of time until variations in reduction rates occur.

where $RED_{i,t} - ANCHOR_{i,t}$ is positive (*POS*=1 and zero otherwise); and periods where $RED_{i,t} - ANCHOR_{i,t}$ is zero [$(1-NEG_{i,t})\times(1-POS_{i,t})$ =1 and zero otherwise]. As shown, $RED_{i,t} - ANCHOR_{i,t}$ is positive in just over half of the sample periods. That difference is negative in 28 percent of the sample periods and unchanged in 21 percent of the sample period.

Table 1B also includes other controls used in the survival analysis. Among those controls, tenant average net annual rent is only 719 dollars, reflecting the very low rental payments associated with public housing. The very low levels of rent suggest damped incentives for residents of public housing to exercise the purchase option. Information on the annual level of current income (*INCOME*) is available for only 1,002 of the 6,853 tenants included in the sample.[15] In the next section, we address the censoring of income and the fact that current income is a poor proxy for permanent income. As shown in the table, the average current monthly income of sampled reporting households is 11,306 US dollars.[16] Also, on average, the net-of-discount purchase price is equivalent to about 2-1/2 years of earnings.

The home purchase analysis includes controls for the cost of mortgage credit, house price volatility, and house price appreciation.[17] On average, the annual long-term mortgage rate (*MORTGAGE_RATE*) was 6.06 percent. Further, based on indices of average transaction prices for the 9 statistical regions in Israel (Israel Central Bureau of Statistics), house price volatility, as measured by the standard deviation of annual yield on housing prices (*APPT_YIELD_STD*), averaged 4.00 percent. The average annual appreciation rate (*APPRECIATION*) is 2.64 percent.

The survival analysis further controls for socio-demographic characteristics of households in the sample. Those controls include duration of residence of the household in the public housing unit (*DURATION*), number of children

[15] Unlike the United States, low-income households in Israel are generally exempted from filing tax returns. Starting in November 2005, public housing tenants were required to file a report documenting their level of income. However, there were only limited sanctions put into place by the Ministry of Housing and Construction for not filing a report. Accordingly, the policy provided an incentive for high-income households to avoid filing such a report.

[16] The average annual net income per household in Israel over the examined period was about $30,000. The $11,306 figure matches the lowest income decile in Israel.

[17] We also included an affordability term defined as the ratio of net ownership price to net rent. This term, however, was statistically insignificant and hence was not included in the final regression output.

(*CHILDREN*), age of household head (*HEAD_AGE*), disability status (*DISABILITY*), tenant confined to wheelchair (*WHEELCHAIR*), and *MARRIED*, *DIVORCED*, *WIDOW*, and *SINGLE PARENT*. As shown in table 1B, the average duration of tenant residence in public housing was about 20 years. About one-third of households had at least 1 child (under 21 years of age) while the average number of children was 1-2. Some 8 percent of the tenants were physically-disabled and 2 percent were confined to a wheelchair. As regards to marital status, some 50 percent of the tenants were married, 6 percent were divorced, 13 percent were widows, 11 percent were single, and about 20 percent of tenants were single parents. Finally, the average age of the household head was 59 years.[18]

As indicated in table 1B, additional variables control for dwelling unit and building structural characteristics. They include the percentage of public housing units in the building (*PUBLIC*), the age of the structure in years (*CONST_AGE*), a dummy variable that equals 1 if there is an elevator in the building (*ELEVATOR*), the story on which the unit is located (*FLOOR*), the number of stories in the structure (*FLOORS*), the number of rooms in the dwelling unit (*ROOMS*), the area of the dwelling unit in square feet (*AREA*), and a dummy variable that equals 1 in the case of a detached housing unit (*DETACHED*). As indicated in the table, public housing units typically comprise about three-quarters of building total dwelling units. Those buildings are typically 32 year old, low-rise, 4-story structures lacking an elevator. The typical public housing unit is an 804-square feet, 3-room apartment, located on the second floor. Eight percent of the public housing units are detached. Finally, as indicated in table 1B, the survival analysis includes regional controls.

4. A First Test of Anchoring: Reduction Rate Decomposition

We now turn to our initial test of anchoring in the home purchase decision. All things equal, we assess whether exercise of the purchase option is conditioned not only on the current price discount, but also on prior price reductions offered to tenants. Below we develop and test a Cox Proportional Hazard model of tenant option exercise.

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[18] A number of factors may have contributed to the relatively older average age of household heads in our sample. Firstly, all construction of new public housing in Israel ceased more than a decade ago and supply of units is highly constrained. At the same time, the low rental prices of public housing incentivize tenants to stay in their units. The combination of these factors may limit opportunities for younger households to enter the public housing system.

Consider the following model consisting of three structural equations:

(1)
$$\begin{aligned}\lambda(t) = \lambda_{00}(t)\exp[&\beta_1 ANCHOR_{i,t} \times NEG_{i,t} + \beta_2 ANCHOR_{i,t} \times POS_{i,t} \\ &+ \beta_3 RED_{i,t} \times NEG_{i,t} + \beta_4 RED_{i,t} \times POS_{i,t} \\ &+ \beta_5 RED_{i,t} \times (1 - NEG_{i,t}) \times (1 - POS_{i,t}) + \beta_6 RENT\_NET_{i,t} \\ &+ \beta_7 \Delta APPT\_YIELD\_STD_t + \beta_8 PROJ(INCOME)_i + \beta_9 \Delta MORTGAGE_t \\ &+ \beta_{10} APPRECIATION_t + \psi_{1,i,t}]\end{aligned}$$

(2)
$$INCOME_i = X_1\gamma_1 + \frac{\phi(z_i^*)}{\Phi(z_i^*)} + u_{1,i},$$

and

(3)
$$z_i^* = X_1\gamma_1 + X_2\gamma_2 + u_{2,i},$$

where t and i represent time-period and household indices, respectively; $\lambda(t)$ is the hazard function, which captures the exercise rate of the option to purchase; $\lambda_{00}(t)$ is the baseline to the hazard function, which reflects variation over time in hazard risk at baseline levels of the covariates. The independent variables in equation (1) include $RED_{i,t}$, the current reduction rate on the dwelling price in percentage points and $ANCHOR_{i,t}$, the mean of all prior reduction rates excluding the current survival period computed separately for each household in every period. The full model includes interaction variables with $ANCHOR_{i,t} \times NEG_{i,t}$ and $ANCHOR_{,i,t} \times POS_{i,t}$; and with $RED_{i,t} \times NEG_{i,t}$, $RED_{i,t} \times POS_{i,t}$, and $RED_{i,t} \times (1 - POS_{i,t}) \times (1 - NEG_{i,t})$, where $NEG_{i,t}$ ($POS_{i,t}$) equals 1 if $RED_{i,t} - ANCHOR_{1,i,t} < 0$ ($RED_{i,t} - ANCHOR_{i,t} > 0$) and 0 otherwise. Among other control variables, $RENT\_NET_{i,t}$ is the net rent paid by the tenant, $\Delta APPT\_YIELD\_\_STD_t$ is the first difference in the volatility of house price returns,[19] $PROJ(INCOME)_i$ is the level of permanent income as generated from equation (2), $\Delta MORTGAGE_t$ is the first difference in the monthly mortgage rates (between periods t and t–1), and $APPRECIATION_t$ represents annual rate of appreciation in the value of the housing unit over time. Finally, $\beta_1, \ldots, \beta_{10}$ are the

[19] Originally, we calculated $APPT\_YIELD\_\_STD_t$ as the 3-year standard deviation of annual price returns on the housing price index. For this time-varying and non-stationary series the unit root hypothesis is clearly not rejected (MacKinnon approximate p-value of 39.40%). The unit root hypothesis similarly is not rejected for $MORTGAGE_t$ (MacKinnon approximate p-value of 87.74%). We thus specify these non-stationary control variables in difference terms. The $APPRECIATION_t$ series is found to be stationary (unit-root hypothesis is rejected at the 5% level).

estimated coefficients associated with equation (1) and $\psi_{1i,t}$ is the random disturbance term.

We observe the behavior of a sample of 6,853 buyers over a timeframe of up to 114 months. The analysis accounts for possible sample selection of buyers in equation (1) due to correlation between affordability of dwelling units and the decision to purchase. As described below, we address potential selection bias using the Heckman two-step selection procedure.[20]

Equations (2) and (3) reflect two auxiliary regressions. The dependent variables include $INCOME_i$, the level of current income, and z_i^*, a binary variable that receives a value of 1 in the case that the tenant purchased the unit during the sample period and 0 otherwise. The $\phi(z_i^*)$ and $\Phi(z_i^*)$ are the normal density, and the cumulative normal density of the likelihood to become a homeowner for each tenant, respectively, where $\frac{\phi(z_i^*)}{\Phi(z_i^*)}$ is the inverse-mills ratio. Finally, the X vectors control for socio-demographic (X_1) and dwelling characteristics (X_2) whereas the γ_1 and γ_2 are vectors of parameters.

Equations (2) and (3) address three potential concerns regarding the dataset. The first is that current income may be a poor proxy for permanent income. The second is that the *INCOME* term is censored for reasons specified earlier (see footnote 15). Thirdly, our sample of purchasers may be subject to selection bias due to difficulties among low-income renter households in affording and financing the purchase of a dwelling unit. Consequently, the Heckman correction is required. Because the level of income is also positively correlated with the decision to buy the dwelling unit, the use of the latter decision as the selection criteria is appropriate.[21] Finally, note that as the projections of the *INCOME* variable derive from a long list of individual socio-demographic, regional, and dwelling characteristics, the two-step

[20] The full set of outcomes from this procedure are given in Appendix A. It should be noted, that estimation of equation (3) is obtained by employing the full sample of 58,665 households who either purchased or not purchased during the sample period. Moreover, estimation of equation (2) is obtained by using the sample of 35,825 households for whom current income is not censored.

[21] The positive and significant Inverse-Mills ratio obtained in the estimation procedure (estimated coefficient of 1,164 and standard error of 135.90) supports the hypothesis of selection bias addressed via this procedure (see appendix A for further details). Also, current annual income of purchasers turns out to be \$1,950.85 higher than non-purchasers – the difference is significant at the 1%-level (calculated *t*-value equals 24.93).

procedure substantially controls for heterogeneity in individual-level preferences for housing purchase (results obtained from this first-step procedure are given in appendix A).

In sum, based on the Heckman selection procedure, we generate a vector of projected income values, which estimates the permanent income of each tenant in the full sample. We then incorporate this vector into the unbalanced panel of 6,853 buyers. In that manner, we address the negative incentive of high-income tenants to report their income level. Further, we address the concern that current income may be a poor proxy for permanent income.

5. RESULTS

Table 2 presents results of regressions that test for the presence of anchoring in tenant decisions to exercise the purchase option. The outcomes in the left-hand column of table 2 (where $RED_{i,t}$ is interacted with $NEG_{i,t}$, $POS_{i,t}$, and $(1-NEG_{i,t})\times(1-POS_{i,t})$, where $RED_{i,t}$ is measured in percentage points) demonstrate the expected behavioral pattern in the case that the restrictions $\beta_1 = \beta_2 = 0$ are imposed. Tenants appear to be highly aware of the current price reduction rate. Indeed, the significant coefficients on the three variables interacted with $RED_{i,t}$ indicate that a 1 percent rise in the price reduction rate increases the hazard to exercise by 3-4 percent.

The unrestricted model (the middle and right columns) is obtained by incorporating the interactions of both *RED* and *ANCHOR* with *NEG* and *POS.* While the middle column refers to outcomes obtained in the case where *ANCHOR* and *RED* are measured in percentage points, the right-hand column refers to outcomes obtained in the case where *ANCHOR* and *RED* are measured in nominal dollar terms. Empirical findings provide solid evidence in support of the anchoring heuristic. The restricted model is statistically rejected in favor of the unrestricted model (which includes the anchoring variables): Each of the coefficient on $ANCHOR_{i,t}\times NEG_{i,t}$ (β_1) and $ANCHOR_{i,t}\times POS_{i,t}$ (β_2) are significant at the 1 percent level.[22]

[22] Furthermore, the null hypothesis that $\beta_1=\beta_2=0$ (i.e., that tenants do not respond to the anchor either under *NEG*=1 or *POS* =1) is rejected at the 1%-level (calculated chi-square values of 146.73 and 697.09, respectively). Also, the smaller log-likelihood of the nominal dollar model compared to the percentage point model (−51,736 compared to −51,415) indicates a somewhat better fit of the latter

Specifically, for the percentage point specification, the estimated coefficients on $ANCHOR_{i,t} \times NEG_{i,t}$ and $ANCHOR_{i,t} \times POS_{i,t}$ imply that a 1 percent increase in the *ANCHOR* term leads to 8 percent reduction and a 0.67 percent rise in the hazard to exercise in the case that *NEG*=1 and *POS* =1, respectively. Similarly, for the nominal dollar specification, the estimated coefficient on $ANCHOR_{i,t} \times NEG_{i,t}$ and $ANCHOR_{i,t} \times POS_{i,t}$ indicate that a $1,000 increase in the *ANCHOR* leads to a 16 percent decline and a 1.95 percent rise in the hazard to exercise in the case that *NEG*=1 and *POS* =1, respectively.[23]

Finally, the estimated coefficients of the control variables are as anticipated. All things equal, purchase option exercise is elevated among tenants with a higher net rent payment. In contrast, an increase in house price volatility serves to defer option exercise. Further, an increase in our proxy for tenant permanent income serves to significantly defer purchase option exercise. Also, as anticipated, an increase in the rate of house price appreciation significantly accelerates home purchase.

6. A SECOND TEST OF ANCHORING: PROJECTED SURVIVAL RATES

In this section we utilize projected survival rates obtained from the Cox regressions to further evaluate the anchoring heuristic. We simulate the response of tenants to hypothetical ascending and descending reduction rate schemes and compare the average price reduction rate at exercise and the average time to exercise under the ascending and descending patterns and across the restricted and unrestricted models (i.e., with and without $ANCHOR_{i,t} \times NEG_{i,t}$ and $ANCHOR_{i,t} \times POS_{i,t}$ in the model).

Specifically, we reconstruct the original panel to produce two time-series of reduction rates for each household—one that is monotonically non-decreasing (hereafter, ascending) and the other that is monotonically non-increasing (hereafter, descending). Based on the estimated coefficients of the model specified in equations (1)-(3), we then predict the response of public housing tenants to the two hypothetical

model (i.e., when reduction rates are measured in percentage points). This is further consistent with the fact that according to the guidelines of the Ministry of Housing and Construction, reduction rates are computed in percentage points rather than dollar values.

[23] The obtained asymmetric response to increases of the anchor figure under *NEG*=1 and *POS*=1 is consistent with loss aversion behavior.

reduction schemes and compute the average number of months until exercise across all households and the average price reduction rate at the time of exercise across all households for each reduction scheme. The anchoring heuristic is supported to the extent tenants react differently to: 1) the ascending and descending price reduction rate schemes; and 2) the restricted and unrestricted specifications within each reduction rate scheme (descending and ascending).

Results of the exercise are reported in figure 1.[24] They provide further evidence in support of the anchoring heuristic. The figure shows that the average projected number of months until exercise generated from the unrestricted model (which includes the *ANCHOR* variables) is 81 months under the ascending scheme and 32 months under the descending scheme. In contrast, the respective figures generated from the restricted model (which excludes the *ANCHOR* variables) are 98 months under the ascending scheme and 93 months under the descending one. The 17-month (61-month) difference associated with the ascending (descending) scheme is significant at the 1 percent level (respective calculated *t*-values of 12.23 and 14.01). Moreover, under the descending pattern, results of the restricted model significantly and severely understate the average exercised reduction rate—only 16 percent

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[24] To compute the average number of months until purchase option exercise and the average reduction rate at the time of exercise (across all households), we estimate two versions of the Cox Proportional Hazard model for all *k*, *k*=(*ascending, descending*), and use it to predict the survival rates at the sample mean. The unrestricted model is given by:

$$\begin{aligned}\lambda(t) &= \lambda_{01}(t)\exp[\omega_1(ANCHOR_{Original,i,t} - ANCHOR_{k,t})\times NEG_{i,t} \\ &+ \omega_2(ANCHOR_{Original,i,t} - ANCHOR_{k,t})\times POS_{i,t} + \omega_3(RED_{Original,i,t} - RED_{k,t})\times NEG_{i,t} \\ &+ \omega_4(RED_{Original,i,t} - RED_{k,t})\times POS_{i,t} + \omega_5(RED_{Original,i,t} - RED_{k,t})\times(1-NEG_{i,t})\times(1-POS_{i,t}) \\ &+ \omega_6(RENT\_NET_{i,t} - 806.43) + \omega_7(\Delta APPT\_YIELD\_STD_t - 5.54\times10^{-2}) \\ &+ \omega_8(PROJ(INCOME)_i - 9{,}429.86) + \omega_9(\Delta MORTGAGE_t + 8.96\times10^{-2}) \\ &+ \omega_{10}(APPRECIATION_t - 0.88) + \psi_{3,i,t}],\end{aligned}$$

where *k*=(*ascending, descending)* represents the constructed ascending and descending price reduction rate schemes, *Original* stands for the actual reduction rate scheme and all other variables are as above described in table 1B. The restricted model is obtained by imposing the restriction $\omega_1 = \omega_2 = 0$.

Again, the control explanatory variables are expressed in terms of deviations from the sample mean and the specification of the model includes equations (2) and (3) as above. We thus produce two vectors of projected survival rates [i.e. for *k* = (*ascending*, *descending*)]. We compute the average number of months until exercise across all households by

$$\sum_{t=1}^{114}\{[PROJ(survival\,rates)_{k,t} - PROJ(survival\,rates)_{k,t-1}]\times t\},$$

where $PROJ(survival\ rates)_{k,t}$ is the projected survival rate at time *t* for the ascending and descending schemes. We also compute the projected average reduction rate at exercise across all households by

$$\sum_{t=1}^{114}[PROJ(survival\,rates)_{k,t} - PROJ(survival\,rates)_{k,t-1}]\times RED_{Exercised,k,t}$$

where $RED_{Exercised,k,t}$ is the average reduction rate across all households who purchased at month *t* (*t*=0,...,114) ordered in ascending/descending patterns.

compared to 46 percent in the unrestricted model. This 30 percent difference is significant at the 1 percent level (calculated *t*-value of 26.50).

Moreover, figure 1 compares the actual average number of months until option exercise and actual average reduction rate at exercise to their values as estimated under the ascending and descending schemes—all for the unrestricted model (that is, including the *ANCHOR* variable). It follows from the figure that while the actual number of months until exercise is 105, that value drops to 81 and 32 months under the ascending and descending reduction rate patterns, respectively. The 49 month difference between the ascending and descending schemes is statistically significant at the 1 percent level (absolute *t*-value equals 6.69). Also, the 24-month (73-month) difference between the actual and ascending (descending) schemes is statistically significant at the 1 percent level (*t*-value equals 10.13 and 9.87, respectively).

Furthermore, the average reduction rate at the time of exercise drops from 78 percent under the ascending scheme to 46 percent under the descending scheme (compared with 68 percent under the actual reduction rate pattern). The 32 percent difference between the ascending and descending schemes is statistically significant at the 1 percent level (absolute *t*-value equals 11.15) and the 22 (10) percent difference between the actual and the descending (ascending) schemes is statistically significant at the 1 percent level (*t*-value equals 20.38 and 19.13, respectively). The above estimates further indicate the statistical and economic significance of the *ANCHOR* term in assessment of purchase option exercise.

Moreover, outcomes of this exercise carry considerable implications for program management. By taking account of anchoring behavior among tenants of public housing, Israeli government managers could both have accelerated the sale of public housing units and reduced the average price reduction rate at time of purchase. Had the government offered equivalent reduction rates, in a descending pattern, the average time-to-exercise would have declined by 73 months and revenues from sale would have increased by 22 percent![25]

[25] Of course, this conclusion maintains as long as tenants cannot predict the descending reduction rate pattern.

7. ROBUSTNESS TESTS

In this section, we report on the results of robustness tests that address the possibility that tenants could have collected information on the likelihood of future reduction rates and thus strategically exercised the purchase option. The first test examines whether all panels contain unit roots. Unlike the standard approach, our objective is to demonstrate that the series in all price reduction panels are non-stationary and that the unit root hypothesis cannot be rejected. Results of four different statistical tests (reported in appendix B) show that the null hypothesis of a unit root in all panels cannot be rejected. The presence of unit roots in purchase option reduction rates would make it difficult for tenants to predict future values.

In other tests, we assess whether households attempted to predict future house price reduction rates based on the varying social policy and privatization agendas of the elected Israeli governments. We thus supplement the Cox regression with dummy variables for the different Israeli governments in power during the sample period. It is important to note that the term until new elections of coalition governments in Israel varies substantially in practice (in fact, one coalition government in our sample period survived only 1-1/2 years prior to new elections). Moreover, due to the cost of the housing privatization program, many of the coalition governments that ruled over the sample period tended to oppose the program (indeed, the privatization program was terminated only a few months following the end our sample period). Test results reveal insignificantly different reactions across different government regimes (LR calculated statistic of 0.02 with 3 degrees of freedom and p-value of 99.93%). It is therefore doubtful that program participants could have predicted either the stability of the governments in power or their specific approaches to the price reduction schemes.

In a further robustness test, we run a Cubic-Spline Cox Proportional Hazard model to account for business cycles and crisis sub-periods within the sample period. Those crisis sub-periods included the second Palestinian uprising (Intifada), three major large scale military actions (including the second Lebanon war) and external events such as the recent global financial crisis. Results of the Cox Proportional Hazard model are robust to this accounting for business cycle and crisis period effects as the hypotheses that β_1 =0 and β_2=0 are rejected at the 1 percent significance level (respective calculated *t*-values of −9.95 and 16.26).[26]

8. Are Anchoring Results Robust to Individual Characteristics?

In the above analysis, we provide evidence in support of price anchoring in home purchase. A remaining question, however, is whether anchoring varies with individual and economic characteristics. Genesove and Mayer (2001) and List (2003, 2004, 2011), for example, provide evidence that anchoring varies with individual experience. Along similar lines, we test (below) whether the anchoring heuristic varies with individual factors such as the age of the household head (*AGE*), household income (*PROJ_INC*), and the percentage of public housing units in the structure (*PUBLIC*).

To undertake these tests, we extend the Cox Proportional Hazard model in the following way:[27]

(4)

$$\begin{aligned}
\lambda(t) = \lambda_{02}(t)\exp[&\theta_1 ANCHOR_{i,t} \times NEG_{i,t} + \theta_2 ANCHOR_{i,t} \times POS_{i,t} \\
&+ \theta_3 ANCHOR_{i,t} \times NEG_{i,t} \times V_i + \theta_4 ANCHOR_{i,t} \times POS_{i,t} \times V_i + \theta_5 RED_{i,t} \times NEG_{i,t} \\
&+ \theta_6 RED_{i,t} \times POS_{i,t} + \theta_7 RED_{i,t} \times (1 - NEG_{i,t}) \times (1 - POS_{i,t}) + \theta_8 RED_{i,t} \times NEG_{i,t} \times V_i \\
&+ \theta_9 RED_{i,t} \times POS_{i,t} \times V_i + \theta_{10} RED_{i,t} \times (1 - NEG_{i,t}) \times (1 - POS_{i,t}) \times V_i + \theta_{11} D_i \times V_i \\
&+ \theta_{12} RENT_NET_{i,t} + \theta_{13} \Delta APPT_YIELD_STD_t + \theta_{14} PROJ(INCOME)_i \\
&+ \theta_{15} \Delta MORTGAGE_t + \theta_{16} PPRECIATION_t + \psi_{1,i,t}],
\end{aligned}$$

where *V*={*AGE, PROJ_INC, PUBLIC*} represents the interaction variables and other variable are as described above. We incorporate in equation (5) six types of interaction terms: $ANCHOR_{i,t} \times NEG_{i,t} \times V_i$; $ANCHOR_{i,t} \times POS_{i,t} \times V_i$; $RED_{i,t} \times NEG_{i,t} \times V_i$; $RED_{i,t} \times POS_{i,t} \times V_i$; $RED_{i,t} \times (1\text{-}NEG_{i,t}) \times (1\text{-}POS_{i,t}) \times V_i$; and $D \times V_i$, where *D* equals 1 in the case where the interaction variable V_i was not specified in the model in equation (1) (i.e., when V_i={AGE_i, $PUBLIC_i$} and 0 otherwise (i.e., when V_i={$PROJ\_INC_i$}). This structure of the model allows $ANCHOR_{i,t}$, and $RED_{i,t}$ to vary with different levels of the specified interaction variable.

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[26] Results of exercise are not presented and are of course available upon request.

[27] Recall that in addition to equation (5) the model also includes equation (2)-(3), from which *PROJ(INCOME)* is generated.

Accordingly, we extend the test of anchoring in equation (1) by estimating the change (increase or decrease) in the hazard to exercise based on the estimated coefficients and given the level of the specified interaction variable. The relevant expressions by which we assess the marginal effect of a 1 percent increase in the anchor on the hazard to exercise for various level of the interaction variable are $\theta_1 + \theta_3 V_i$ and $\theta_2 + \theta_4 V_i$ for *NEG*=1 and *POS*=1, respectively.

Tables 3 reports the results of interacting the anchoring variable with *AGE*, *PROJ_INC*, and *PUBLIC*. Results provide evidence of significant individual variation in anchoring heuristics. In both cases where $RED - ANCHOR < 0$ and $RED - ANCHOR > 0$ (i.e., when *NEG*=1 and *POS*=1, respectively), the coefficient on the interaction term, θ_3 and θ_4, respectively, is significant at the 1 percent level.

Figures 2A-2C plot the marginal effect of an increase in the anchor by one unit (i.e., 1 percent) on the hazard to exercise for different levels of the interaction variable (we only draw the effect of the interaction terms for *NEG*=1 as it is practically more significant than for *POS*=1).[28] It follows that age of household head (*AGE*) moderates the anchoring effect: while a 1 percent increase in the anchor for a 20 year old leads to 14 percent drop in the hazard to exercise, the equivalent decrease in the hazard to exercise for a 60-year old is only 7 percent. We also find that income positively correlates with the anchoring effect: increasing the anchor by 1 percent when annual income equals 6000 dollars leads to only a 0.8 percent decline in the hazard to exercise, whereas increasing the anchor by 1 percent when annual income equals $15,000 results in a full 19 percent reduction in the hazard rate of option exercise.[29]

Finally, the percentage of units under public housing in the structure attenuates the effect of the anchor. Increasing the anchor by 1 percent when all other units in the structure are privately owned results in a 16 percent drop in the hazard to exercise, whereas the equivalent drop in the hazard to exercise is only 6 percent when all other dwelling units in the structure are under public housing. This finding indicates that potential buyers may also use the reduction rates offered to tenants in the structure as

[28] Equivalent graphs for the case where *POS*=1 are of course available upon request.

[29] Our finding on the age-anchor interaction is somewhat inconsistent with Mather, Mazar, Gorlick, Lighthall, Burgeno, Schoeke, and Ariely (2012) who find that age (weakly) positively correlates with loss aversion. Per our outcome on the income-anchor interaction, recall that, as previously reported, the average projected annual income of public housing tenants in our sample is just over 11,306 dollar, which matches the lowest income decile in Israel.

possible anchors, thereby moderating the effect of their own past offered reduction rates as the anchor in exercising the purchase.

9. SUMMARY AND CONCLUSION

This research provides new empirical evidence of the role of the anchoring heuristic in household decisions and in management of public program outcomes. The analysis employs a unique dataset from a natural policy experiment to privatize public housing in Israel. The government programs, which date from 1999, provide public housing tenants with a call (real) option to purchase their dwelling unit at a discounted exercise price.

In the analysis, we specify two statistical tests and demonstrate the prevalence of the anchoring heuristic among home purchasers. To demonstrate the practical implications of our findings, we simulate ascending and descending house price reduction rate schemes and show in retrospect that, by accounting for the anchoring heuristic, government program managers could both have accelerated the sale of public housing units and raised the average sales price at option exercise. Compared to the actual scheme offered to program participants, the average time-to-exercise would have declined by 73 months and revenues from sale of those units would have increased by 22 percent. We further find evidence that anchoring varies with individual and housing market characteristics. Research findings provide real world evidence suggesting the importance of behavioral heuristics to housing decisions and to the management of public programs.

ACKNOWLEDGEMENTS

The authors thank Yaakov Brosh (CEO), Ronit Gerafi, and Reuven Tunkelrot of Amidar Ltd. for provision of project data. We are also grateful to Smadar Shatz of Bar Ilan University for invaluable assistance in generating the dataset and to Shlomo Benartzi, Nahum Bigger, Maarten Buis, Denise DiPasquale, David Genesove, Benny Lauterbach, Dan Quan, Bradley Ruffle, Tammie Simmons-Mosley, Avanidhar Subrahmanyam, and seminar participants at the Hebrew University of Jerusalem, Bar Ilan University, and the 2012 ASSA/AREUEA meetings for helpful comments. We thank the Israel Science Foundation for financial support.

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Table 1A: List of Variables, Definitions, and Summary Statistics: Cross-Section of Buyers at the Date of Purchase

Name	Variable Definition	Avg.	Std.	Min	Max
APPT_VALUE ($)	Value of housing units translated to dollars	89,509	29,387	20,625	269,193
$RED_{i,t}$	Current price reduction rate in percentage points	78	16	5	95
$RED\_DOLLAR_{i,t}$	Current price reduction rate translated to dollars	69,955	27,380	1,963	176,163
$ANCHOR_{i,t}$	accumulated average of all previous (up to *t*-1) price reduction rates	53	22	1	91

Note: Table 1A refers to the summary statistics of the main variables of interest and economic explanatory control variables and on-sample 6,853 purchasers at the date of purchase. All the variables measured in NIS (the local Israeli currency) are translated to dollars, where 1 NIS roughly equals $0.25

Table 1B: List of Variables, Definitions, and Summary Statistics for On-Sample Panel

Name	Variable Definition	Avg.	Std.	Min	Max
APPT_VALUE ($)	Value of housing units translated to dollars	86,879	31,223	18,286	265,161
$RED_{i,t}$	Current price reduction rate in percentage points	45	34	0	95
$RED_{i,t}$*_DOLLAR*	Current price reduction rate in US dollars	38,936	32,967	0	196,712
$ANCHOR_{i,t}$	accumulated average of all previous price reduction rates	37	27	0	91
$NEG_{i,t}$	1 – cases where $RED_{i,t}$–$ANCHOR_{i,t}$ <0; 0 – otherwise	0.28	0.45	0	1
$POS_{i,t}$	1 – cases where $RED_{i,t}$–$ANCHOR_{i,t}$ >0; 0 – otherwise	0.51	0.50	0	1
$(1-NEG_{i,t})\times(1-POS_{i,t})$	1 – cases where $RED_{i,t}$–$ANCHOR_{i,t}$ =0; 0 – otherwise	0.21	0.40	0	1
RENT_NET ($)	Net annual rent payment	719	709	12	7,383
APPT_YIELD_STD (% Points)	Standard deviation of monthly return of housing units	4	1	2	7
$INCOME_i$ ($)	the level of annual current income in US dollars	11,306	3,975	879	42,045
MORTGAGE_RATE	long term monthly mortgage rate in percentage points	6.06	0.59	4.06	6.88
APPRECIATION	Annual appreciation of housing unit value in percentage points	2.64	5.40	-30.62	79.59

Note: Table 1B refers to the summary statistics of on-sample main variables of interest and economic explanatory control variables across all time periods (excluding the date of purchase). The summary statistics of the variables APPT_VALUE, $RED_{i,t}$,$RED_{i,t}$–*MEAN_ACC*($RED_{i,\tau-1}$), $AFFORD_{i,t}$,, RENT_NET, APPT_STD, MORTGAGE_RATE, APPRECIATION refer to 6,853 tenants across 314,840 time periods. The summary statistic of the INCOME variable refers to 1,002 tenants across 95,492 time periods. All the variables measured in *NIS* (the local Israeli currency) are translated to dollars, where 1 *NIS* roughly equals $0.25

Table 1B: List of Variables, Definitions, and Summary Statistics for On-Sample Panel (Cont.)

Name	Variable Definition	Avg.	Std.	Min	Max
$DURATION_{i,t}$	number of years in the public housing project	20.05	9.64	0.67	51.83
$CHILDREN_{i,t}$	number of children below 21 years for tenant *i* at time *t*	1.48	1.94	0	12
$DISABILITY_i$	1 – if at least one person in the household is physically-disabled 0 -otherwise	0.08	0.27	0	1
$WHEELCHAIR_i$	1 – if the person or his spouse is confined to a wheelchair 0 – otherwise	0.02	0.15	0	1
$MARRIED_i$	1 – married 0 – otherwise	0.50	0.50	0	1
$DIVORCED_i$	1 – divorced 0 – otherwise	0.06	0.24	0	1
$WIDOW_i$	1 – widow 0 – otherwise	0.13	0.34	0	1
$SINGLE\_PARENT_i$	1 – single parent 0 – otherwise	0.20	0.40	0	1
$SINGLE_i$	1 – single 0 – otherwise	0.11	0.31	0	1
AGE_i	age of the head of the household in years	59.13	14.05	28	104
$PUBLIC_i$	Percentage of public housing units in the structure	74.49	36.25	1.04	100.00
$CONST\_AGE_j$	Age of structure	31.79	9.54	4.75	57.75
$ELEVATOR_j$	1 – if there is an elevator in the structure 0 – otherwise	0.13	0.34	0	1
$ENTRANCES_i$	Number of entrances	2.28	1.69	1	14
$SHELTERS_i$	Number of shelters	0.35	0.54	0	2
$FLOOR_j$	The floor in which the housing unit is located	2.26	1.42	0	15
$FLOORS_j$	The total number of floors in the structure	4.02	1.92	1	16
$ROOMS_i$	Number of rooms	3.21	0.77	1	9.5
$AREA_i$	the area of the housing unit in square feet	804.30	174.77	215.28	1,628.58

Table 1B: List of Variables, Definitions, and Summary Statistics for On-Sample Panel (Cont.)

Name	Variable Definition	Avg.	Std.	Min	Max
$DETACHED_j$	1 – if the housing unit is one-story detached structure 0 – otherwise	0.08	0.27	0	1
$HAIFA_j$	1 – if the location is in Haifa 0 – otherwise	0.05	0.22	0	1
$NORTH_j$	1 – if the location is in the North 0 – otherwise	0.14	0.35	0	1
$GUSH\_DAN_j$	1 – if the location is in Gush Dan 0 – otherwise	0.19	0.39	0	1
$SOUTH_j$	1 – if the location is in the South 0 – otherwise	0.19	0.39	0	1
$JERUSALEM_j$	1 – if the location is in Jerusalem 0 – otherwise	0.10	0.30	0	1
$CENTER_j$	1 – if the location is in the center 0 – otherwise	0.15	0.36	0	1
$KRAYOT_j$	1 – if the location is in the Krayot (near Haifa) 0 – otherwise	0.00	0.04	0	1
$SHARON_j$	1 – if the location is in the Sharon 0 – otherwise	0.16	0.36	0	1
TEL_AVIV_j	1 – if the location is in the Tel Aviv 0 – otherwise	0.02	0.14	0	1

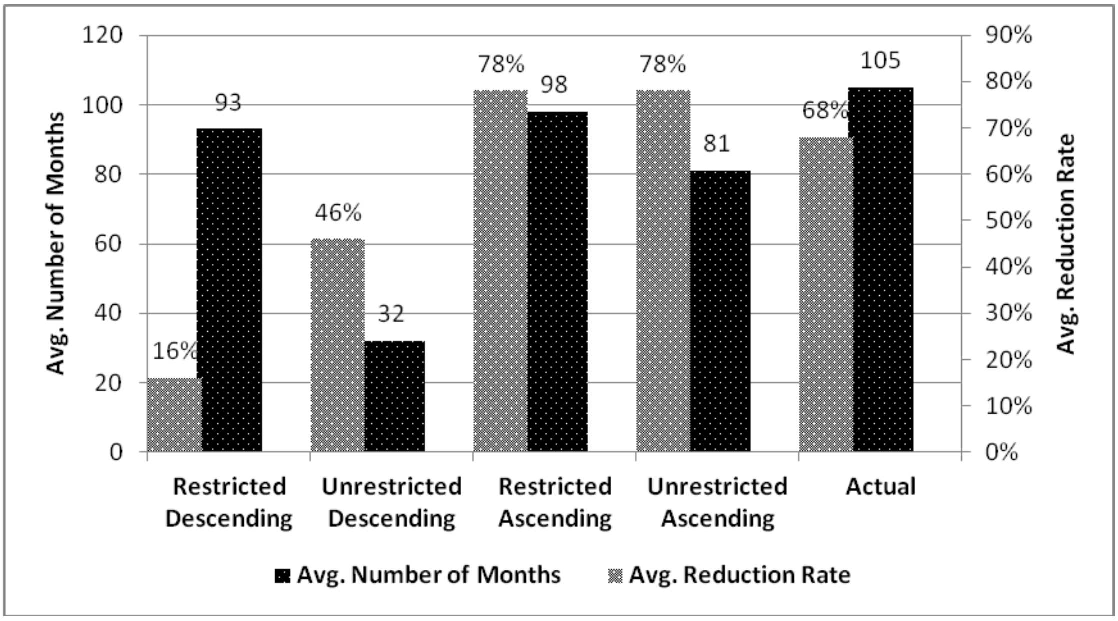
Note: The statistical summary of the variables APPT_VALUE, $RED_{i,t}$, $RED_{i,t}$– *MEAN_ACC*($RED_{i,t-1}$), $AFFORD_{i,t}$, APPT_STD, MORTGAGE_RATE, $AMIDAR\_PER_i$, DURATION, $CHILDREN_{i,t}$, $HANDICAPPED_i$, $WHEELCHAIR_i$, MARRIED, DIVORCED, WIDOW, SINGLE_PARENT, SINGLE, HEAD_AGE, VEHICLE, CONST_AGE, ELAVATOR, FLOOR, FLOORS, ROOMS, AREA, DETACHED, HAIFA, NORTH, GUSH_DAN, SOUTH, JERUSALEM, CENTER, KRAYOT, SHARON and TEL AVIV refers to 6,853 tenants across 314,840 time periods. For the variables INCOME the statistical summary refers to 1,002 tenants across 95,492 time periods

Table 2: Testing for Anchoring Effects using Cox Regressions

Coefficient of:	denoted	percentage restricted	percentage unrestricted	Thousands of Dollars unrestricted
$ANCHOR \times NEG$	β_1	–	–0.08	–0.16
		–	(7.61×10^{-3})***	(1.04×10^{-2})***
$ANCHOR \times POS$	β_2	–	6.76×10^{-3}	1.95×10^{-2}
		–	(1.04×10^{-3})***	(9.46×10^{-4})***
$RED \times NEG$	β_3	0.03	0.11	0.19
		(1.34×10^{-3})***	(7.92×10^{-3})***	(1.09×10^{-2})***
$RED \times POS$	β_4	0.03	0.02	4.65×10^{-3}
		(6.33×10^{-4})***	(1.03×10^{-3})***	(6.87×10^{-4})***
$RED \times (1-NEG) \times (1-POS)$	β_5	0.04	0.04	0.04
		(2.54×10^{-3})***	(2.54×10^{-3})***	(3.43×10^{-3})***
RENT_NET	β_6	1.55×10^{-4}	1.49×10^{-4}	-4.44×10^{-6}
		(1.69×10^{-5})***	(1.69×10^{-5})***	(1.78×10^{-5})
$\triangle$ *APPT_YIELD_STD*	β_7	0.13	0.13	0.06
		(0.24)	(0.23)	(0.23)
PROJ(INCOME)	β_8	-1.51×10^{-5}	-2.44×10^{-5}	-1.00×10^{-4}
		(6.62×10^{-6})**	(6.81×10^{-6})***	(6.72×10^{-6})***
$\triangle$ *MORTGAGE*	β_9	0.34	0.29	0.50
		(0.74)	(0.74)	(0.81)
APPRECIATION	β_{10}	0.02	0.02	7.23×10^{-3}
		(4.11×10^{-3})***	(4.12×10^{-3})***	(4.10×10^{-3})*
Regression Statistics:				
$MONTHS \times SUBJECTS$		314,840	314,840	314,840
SUBJECTS		6853	6853	6853
FAILURES		6853	6853	6853
LR STATISTICS		4925	5129	4488
LOG LIKELIHOOD		-51517	-51415	-51736
Calculated Chi-Square				
Anchoring Hypothesis:	$\beta_1=\beta_2=0$	–	146.73***	697.09***

Notes: The table displays the survival analysis outcomes obtained by employing the Cox Proportional Hazard model. The sample contains an unbalanced panel of public housing tenants indexed as i=1,…,6,853. We follow their behavior across time, where the time index (t=0,1,..,114) is given in months and covers the period of 1999-2008. The dependent variable in the model is the level of hazard to survival. The $ANCHOR_{i,t}$ variable, which was calculated for each household separately, is the mean of all prior reduction rates excluding the current survival period. The full model includes interaction variables with $ANCHOR_{i,t}$: $ANCHOR_{i,t} \times NEG_{i,t}$ $ANCHOR_{i,t} \times POS_{i,t}$,and with $RED_{i,t}$: $RED_{i,t} \times NEG_{i,t}$, $RED_{i,t} \times POS_{i,t}$,and $RED_{i,t} \times (1-POS_{i,t}) \times (1-NEG_{i,t})$, where $NEG_{i,t}$ ($POS_{i,t}$) equals 1 if $RED_{i,t} - ANCHOR_{i,i,t} < 0$ ($RED_{i,t} - ANCHOR_{i,t} > 0$) and 0 otherwise. These variables are measured in percentages (thousand of dollars) in the left two columns (right column). All the regressions incorporate the variable *PROJ*(INCOME), the projected values of the current income obtained from the Heckman two-step selection procedure and translated to dollars. This procedure is applied to the full sample of renters and buyers and addresses the problems of censored income and selection bias. Standard errors are given in parentheses. * significant at a level of 10%, ** significant at a level of 5% and *** significant at a level of 1%.

Figure 1: Average Exercised Reduction Rates and Number of Months until Option Exercise across Descending, Ascending, and Actual Reduction Rate Schemes



<u>Notes</u>: The ascending and descending schemes were generated by sorting the actual reduction rates each tenant faces. We calculated the projected exercised reduction rates under the ascending (descending) schemes as: $\sum_{t=0}^{114} PROJ(\text{exercise\_rates}) \times REDUCT\_PER(fail=1)$, where $PROJ(\text{exercise\_rates})$ is calculated from the projected survival rates for t=0,...,114 obtained from the Cox Regression and *REDUCT_PER*(*fail=1*) is the average reduction rate across all households who purchased at month t (t=0,...,114) under the ascending (descending) scheme. The difference between reduction rates under the descending schemes across all periods generated from the restricted and unrestricted model is statistically significant at the 1%-level (absolute calculated t-values of 26.50). The difference between reduction rates under the ascending schemes across all periods generated from the restricted and unrestricted models is statistically significant at the 1%-level (absolute calculated *t*-values of 18.06). The average reduction rate at the time of exercise drops from 78 percent under the ascending scheme to 46 percent under the descending scheme (compared with 68 percent under the original pattern). The 32 percent difference between the ascending and descending schemes is statistically significant at the 1% level (absolute *t*-value equals 11.15). The 22 (10) percent difference between the original and the descending (ascending) schemes is statistically significant at the 1%-level (*t*-value equals 20.38 and 19.13, respectively). We calculated the average number of months until exercise as $\sum_{t=0}^{114} PROJ(\text{exercise\_rates}) \times t$ where $PROJ(\text{exercise\_rates})$ is calculated from the projected survival rates obtained from the Cox Regression and t is the time index in months (t=0,...,114). The difference between number of months under the descending schemes across all periods generated from the restricted and unrestricted model is statistically significant at the 1%-level (absolute calculated t-values of 14.01).The difference between number of months under the ascending schemes across all periods generated from the restricted and unrestricted model is statistically significant at the 1%-level (absolute calculated t-values of 12.23). The 49-month difference between the ascending and descending schemes is statistically significant at the 1% level (absolute *t*-value equals 6.69). Also, the 24-month (73-month) difference between the original and ascending (descending) schemes is statistically significant at the 1% level (*t*-value equals 10.13 and 9.87, respectively).

Table 3: Testing the Interaction of the Anchoring Effect with *AGE*, *PROJ_INC*, and *PUBLIC*

Coefficient of:	denoted	*AGE*	*PROJ_INC*	*PUBLIC*
$ANCHOR \times NEG$	θ_1	–0.18	0.12	–0.06
		(0.03)***	(0.03)***	(8.19×10^{-3})***
$ANCHOR \times POS$	θ_2	0.02	-9.34×10^{-3}	6.60×10^{-3}
		(3.14×10^{-3})***	(4.12×10^{-3})**	(1.13×10^{-3})***
$ANCHOR \times NEG \times V$	θ_3	1.73×10^{-3}	-2.07×10^{-5}	-9.47×10^{-4}
		(4.58×10^{-4})***	(3.68×10^{-6})***	(3.18×10^{-4})***
$ANCHOR \times POS \times V$	θ_4	-2.80×10^{-4}	1.55×10^{-6}	5.79×10^{-5}
		(5.07×10^{-5})***	(4.06×10^{-7})***	(1.72×10^{-5})***
$RED \times NEG$	θ_5	0.26	–0.13	0.09
		(0.03)***	(0.03)***	(8.49×10^{-3})***
$RED \times POS$	θ_6	2.97×10^{-2}	9.32×10^{-3}	0.02
		(3.40×10^{-3})***	(4.44×10^{-3})**	(1.21×10^{-3})***
$RED \times (1-NEG) \times (1-POS)$	θ_7	0.13	0.01	0.04
		(1.44×10^{-2})***	(0.02)	(2.78×10^{-3})***
$RED \times NEG \times V$	θ_8	-2.52×10^{-3}	2.59×10^{-5}	1.12×10^{-3}
		(4.96×10^{-4})***	(3.85×10^{-6})***	(3.31×10^{-4})***
$RED \times POS \times V$	θ_9	-7.65×10^{-5}	1.67×10^{-6}	6.65×10^{-5}
		(5.57×10^{-5})	(4.54×10^{-7})***	(2.04×10^{-5})***
$RED \times (1-NEG) \times (1-POS) \times V$	θ_{10}	-1.71×10^{-3}	2.81×10^{-6}	8.85×10^{-5}
		(3.08×10^{-4})***	(2.17×10^{-6})	(1.07×10^{-4})
V	$\theta_{11}-\theta_8$	0.02	-2.39×10^{-4}	-6.27×10^{-3}
		(3.59×10^{-3})***	(2.96×10^{-5})***	(1.45×10^{-3})***

Notes: The table displays the survival analysis outcomes obtained by employing the Cox Proportional Hazard model. The sample contains an unbalanced panel of public housing tenants indexed as i=1,…,6,853. We follow their behavior across time, where the time index (t=0,1,..,114) is given in months and covers the period of 1999-2008. The tenants fail to survive (failure=1) and are excluded from the sample when they decide to exercise the purchase. The dependent variable in the model is the level of hazard to survival. We run the Cox regression separately on the following explanatory variables: V_i=*PROJ_INC* (annual projected income measured in US Dollars) and *PRIVATIZED* (percentage of privatized units in the structure).The $ANCHOR_{i,t}$ variable, which was calculated for each household separately, is the mean of all prior reduction rates excluding the current survival period. The full model includes interaction variables with $ANCHOR_{i,t}$: $ANCHOR_{i,t} \times NEG_{i,t}$; $ANCHOR_{i,t} \times POS_{i,t}$; $ANCHOR_{i,t} \times NEG_{i,t} \times V_i$; $ANCHOR_{i,t} \times POS_{i,t} \times V_i$; and with $RED_{i,t}$: $RED_{i,t} \times NEG_{i,t}$; $RED_{i,t} \times POS_{i,t}$; $RED_{i,t} \times (1-POS_{i,t}) \times (1-NEG_{i,t})$; $RED_{i,t} \times NEG_{i,t} \times V_i$; $RED_{i,t} \times POS_{i,t} \times V_i$; and $RED_{i,t} \times (1-POS_{i,t}) \times (1-NEG_{i,t}) \times V_i$, where $NEG_{i,t}$ ($POS_{i,t}$) equals 1 if $RED_{i,t} - ANCHOR_{1,i,t} < 0$ ($RED_{i,t} - ANCHOR_{i,t} > 0$) and 0 otherwise. All the regressions incorporate additional control variables, which their estimated coefficients are not reported here. Standard errors are given in parentheses. * significant at a level of 10%, ** significant at a level of 5% and *** significant at a level of 1%.

Figure 2A: The Effect of 1%-Increase in the Anchor on the Hazard to Exercise for Different Levels of *AGE* (when *NEG*=1)

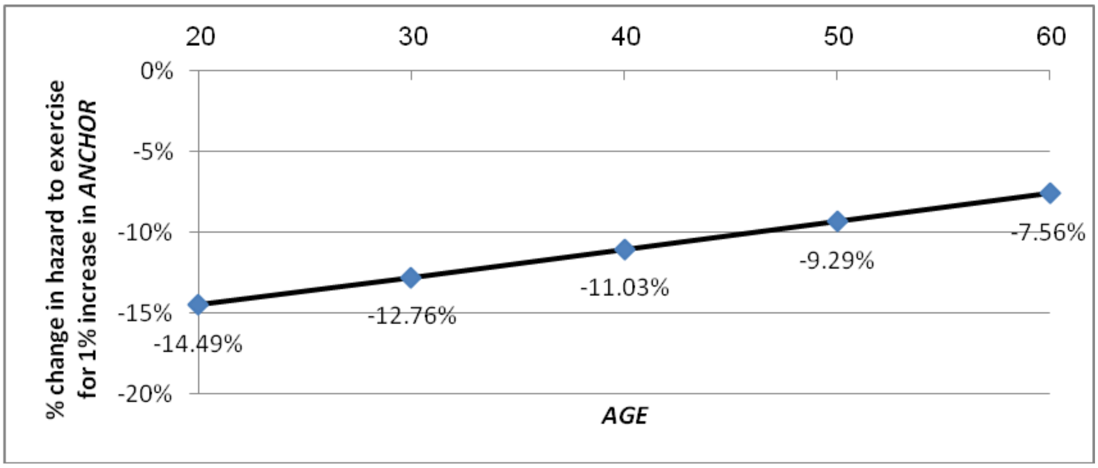


Figure 2B: The Effect of 1%-Increase in the Anchor on the Hazard to Exercise for Different Levels of *PROJ_INC* (when *NEG*=1)

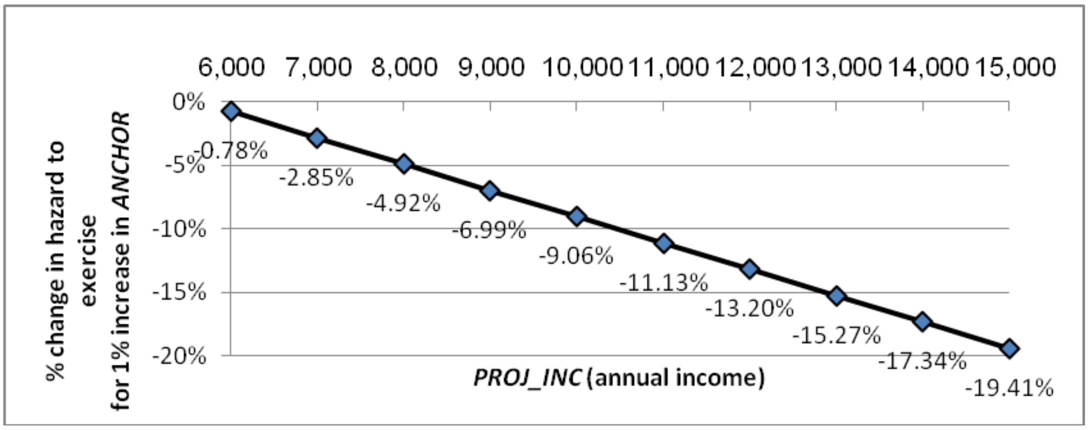
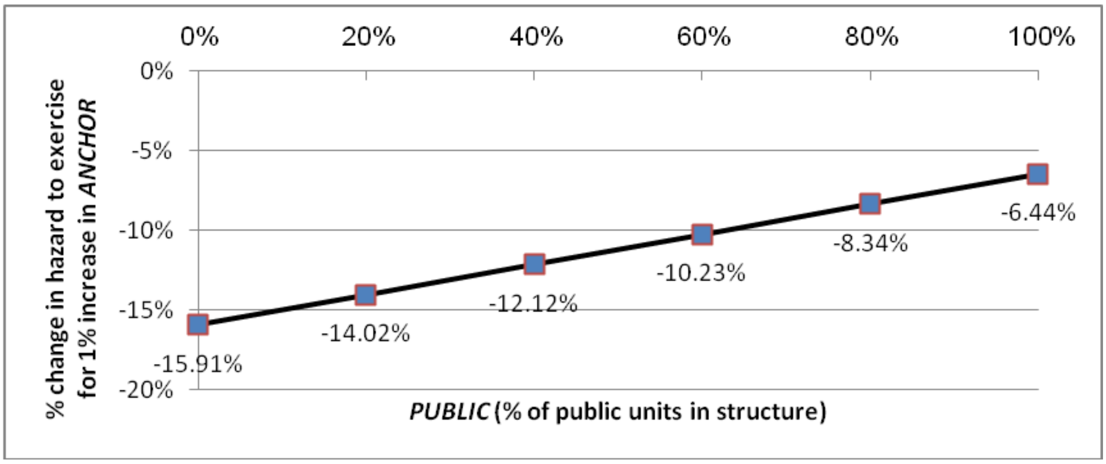


Figure 2C: The Effect of 1%-Increase in the Anchor on the Hazard to Exercise for Different Levels of *PUBLIC* (when *NEG*=1)



Appendix A: Auxiliary Regressions for generating Permanent Income

VARIABLES	Equation (3)	Equation (2)
$DURATION_i$	9.636	-0.0343
	(3.476)***	(0.000627)***
$CHILDREN_i$	–	0.161
	–	(0.00491)***
$DIVORCED_i$	-3,799	0.618
	(70.20)***	(0.0203)***
$WIDOW_i$	-3,081	0.424
	(71.78)***	(0.0190)***
$SINGLE\_PARENT_i$	-1,912	0.606
	(71.27)***	(0.0170)***
$SINGLE_i$	-5,177	0.132
	(66.60)***	(0.0191)***
D_i	12.90	0.0126
	(0.927)***	(0.000228)***
$WHEELCHAIR_i$	-880.1	-0.907
	(231.7)***	(0.0599)***
$HEAD\_AGE_i$	-11.93	0.0219
	(1.910)***	(0.000512)***
$NORTH_i$	230.3	0.210
	(95.26)**	(0.0275)***
$GUSH\_DAN_i$	700.0	-0.357
	(112.2)***	(0.0304)***
$SOUTH_i$	3.962	0.249
	(94.71)	(0.0274)***
$JERUSALEM_i$	1,090	-0.269
	(123.7)***	(0.0333)***
$CENTER_i$	617.5	-0.0474
	(108.7)***	(0.0301)
$KRAYOT_i$	813.2	-0.00886
	(698.5)	(0.213)
$SHARON_i$	570.7	-0.259
	(111.8)***	(0.0299)***
TEL_AVIV_i	658.1	-0.297
	(183.2)***	(0.0512)***
$AREA_i$	–	-0.000253
	–	(6.53e-05)***
$ROOMS_i$	–	-0.161
	–	(0.0142)***
$FLOOR_i$	–	0.0392
	–	(0.00490)***
$FLOORS_i$	–	0.0212
	–	(0.00499)***

Appendix A: Auxiliary Regressions for generating Permanent Income (continued)

VARIABLES	Equation (3)	Equation (2)
$ELEVATOR_i$	–	0.0195
	–	(0.0297)
$SHELTERS_i$	–	0.113
	–	(0.00943)***
$ENTRANCES_i$	–	0.0192
	–	(0.00318)***
$CONST\_AGE_i$	–	0.0157
	–	(0.000400)***
$PUBLIC_i$	–	-0.00222
	–	(0.000236)***
Inverse-Mills Ratio	–	1,164
	–	(135.9)***
Constant	11,216	-0.975
	(178.9)***	(0.0594)***
Observations	58,665	58,665
Censored Obs.	22,840	22,840
Chi Square Statistics	8822	8822

Notes: The table displays the auxiliary regression from which the permanent income has been generated for each household in the sample. The dependent variable in the selection equation is the probability to report the level of income. Numbers in parentheses are standard errors. Significant values at a 5% (1%) level are marked with two (three) asterisks

Appendix B: Testing Unit-Roots in Reduction Schemes of All Panels

Fisher-Type based on ADF Unit-Root Test	Statistic	p-value
Inverse chi-squared test	5,520.99	1.00
Inverse normal	53.53	1.00
Inverse logit	49.05	1.00
Modified inverse chi-squared	-49.44	1.00

Notes: The four tests examine the null hypothesis that all 6,853 panels contain unit roots based on Augmented Dickey Fuller tests.