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MEMORY AND REFERENCE PRICES: AN APPLICATION TO RENTAL CHOICE

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ABSTRACT

Simonsohn and Loewenstein (SL 2006) present evidence that a household moving from one US city to another tends to pay a rent level that is closer to the city of origin, relative to comparable locals. Building on "Memory, Attention, and Choice" (BGS 2019), we show that these effects emerge from the interaction between memory and attention. In our model, memory is a database of experiences such as rents. The current rent cues recall of past rents, giving rise to a rental norm. A large discrepancy between the current rent and the memory-based norm surprises and attracts the mover's attention, distorting choice. Thus, when rents in Pittsburgh cue recall of rent experiences in San Francisco, they look surprisingly cheap by comparison, leading the household to spend more. We revisit the SL evidence in light of the model. Besides generating the basic SL findings, our model yields two new predictions, which we test and confirm using 20 additional years of data.

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A data appendix is available at http://www.nber.org/data-appendix/w25650

Memory and Reference Prices: an Application to Rental Choice

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Simonsohn and Loewenstein (SL 2006) present evidence that, controlling for income and many other individual characteristics, a household moving from one US city to another with lower rents, say San Francisco to Pittsburgh, tends to rent a more expensive apartment relative to comparable locals. The reverse is true for a person moving from a cheap to an expensive city, say from Atlanta to New York. This effect is however temporary. Over time, movers converge to the choices of comparable locals. This behavior is puzzling in light of standard theory, in which a mover's reservation rent in Pittsburgh does not depend on what he paid in San Francisco.

SL argue that a plausible explanations of their findings relies on Simonson and Tversky's (1992) background context effect, whereby a mover's experience with high San Francisco rents leads him to see Pittsburgh rents as cheap and so willing to rent an expensive apartment. But what is the precise psychology of this effect?

In "Memory, Attention, and Choice" (BGS 2019), we show that these effects emerge from the interaction between memory and attention. In our model, memory is a database of experiences such as rents. The current rent cues recall of past rents, giving rise to a rental norm. A large discrepancy between the current rent and the memory-based norm surprises and attracts the mover's attention, distorting choice. When rents in Pittsburgh cue recall of rents in San Francisco, they look surprisingly cheap by comparison. The surprise attracts the mover's attention, leading him to spend more than he would otherwise. The model also explains why these effects are temporary: with experience, Pittsburgh rents populate the mover's database, and the rent norm adapts.

BGS (2019) show that the interaction between memory and attention unifies many effects studied in behavioral economics, ranging from experience effects, to projection bias, to inattention, to reference effects. Here we revisit the SL evidence in light of that model. Besides generating the

basic SL findings, our model yields two new predictions, which we test and confirm using 20 additional years of data.

I. The Model

We consider the mover's willingness to pay for a rental of quality q. This mover receives offers drawn from the city's rent distribution for q, and accepts rents below his willingness to pay. By shaping the willingness to pay, the memory-based reference rent shapes the average rent paid by the consumer for q.

The renter faces a choice set $C = \{(q, p), (0,0)\}$ between renting apartment q at rent p and not renting. Observing the current attributes (q, p) cues recall of past renting experiences. Because q is fixed, recall is only meaningful for rent.

A. Associative Memory

Suppose that the average rent in the destination city is p_d, that in the origin city is p_o. The memory database is described by a distribution over these rents $\{p_o, p_d\}$ where $\pi_t \in [0,1]$ is the frequency with which p_d has been experienced by time t. A higher π_t is either due to the fact that the mover has stayed longer in the destination city or because he has lived in cities with similar rents in the past.

Upon observing rent p at time t, the mover recalls similar prices from the database. In this recall, he overweighs rents similar to p, where similarity with a rent p' is measured by the function $S(|p - p'|)$, where $S(.)$ is decreasing in distance. Cued by the destination city rent p_d, the memory based rent norm is thus the *similarity weighted* average of past experienced rents (see Kahana 2012).

(1) $\quad p^n = p_o + w(p_d)(p_d - p_o),$

where weight $w(p_d) \equiv \frac{S(0)\pi_t}{\pi_t S(0) + (1-\pi_t) S(|p_d - p_0|)}$ captures the similarity-distorted past experience with p_d.

Equation (1) has three properties. First, a mover exposed to higher rents in the city of origin has a higher norm p^n, since a higher p_o makes higher rents available for recall. Second, similarity

causes adaptation to the current rent. Formally, the weight $w(p_d)$ is distorted toward p_d relative to the experienced frequency π_t (when similarity is strong, $S(0) \to \infty$, adaptation is full). Third, experience with the destination city, or past experiences in similar cities (a higher π_t), also causes the norm to be closer to p_d. Consulting Zillow increases π_t, but does not eliminate city of origin rents from the database, especially right after the move when experience with p_o is so recent.

B. Salience and Valuation

As the mover retrieves the norm p^n, he values a rental p according to the salience distorted valuation:

(2) $V^n(q, p_t) = q - p_t - \sigma(p, p^n)[p_t - p^n]$

where $\sigma(x, y)$ is a salience function that is symmetric, homogeneous of degree zero and increasing in x/y for $x \geq y$. Salience here is modeled similarly to Bordalo, Gennaioli, and Shleifer (2013), except it operates on the surprise relative to the norm. It captures the idea that the surprise (or error in expectations) attracts attention, and is consequently overweighed in decisions. Homogeneity of degree zero captures Weber-Fechner law of sensory perception: a given distance between the current rent and the norm $|p_t - p^n|$ is more salient at lower price levels. A salient difference between the current rent and the norm is overweighed in valuation. Thus a low rent relative to the norm positively surprises the mover, attracts his attention, and boosts the valuation of the rental, and the reverse for high rent. Willingness to pay is then defined as the rent p_{WTP} for which $V^n(q, p_{WTP}) = 0$.

C. Predictions

Equations (1) and (2) yield several predictions about p_{WTP} (proofs available in Web Appendix).

Prediction 1 (Anchoring). WTP increases in p_o, that is $\frac{\partial p_{WTP}}{\partial p_o} > 0$. The rent paid on average after moving to the destination city increases in the rent level in the city of origin.

Higher p_o increases the price norm p^n. By comparison, any given local rent seems relatively more attractive, which increases the mover's willingness to pay.

Prediction 2 (Adaptation from experience). If the household moves again in the destination city, the rent paid subsequently depends less on the city of origin: $sign\left(\frac{\partial p_{WTP}}{\partial \pi_t}\right) = sign(p_d - p_o)$.

By the time he rents again, the mover has greater experience π_t with local rents. Thus, his norm is more adapted to the local rent (for $w(p_d) = 1$ the mover's rental choice no longer depends on p_o).

Predictions 1 and 2 were both tested in SL (2006). The following two predictions are new.

Prediction 3 (Adaptation from similarity). Rent in city of origin has a smaller effect on rent paid in the destination city for movers who had previously lived in cities with rents similar to p_d.

In our setting, this is identical to Prediction 2 because we assume that living long ago in a city with rent p_d affects norms similarly to living in the destination city. This is akin to having greater experience π_t with p_d. Due to similarity, these rents are recalled even if experienced long in the past, which increases adaptation to the current rent, reducing the influence of the rent in the city of origin p_o.

Prediction 4 (Asymmetry). Rent in city of origin has a stronger effect on rent paid for movers to cheaper cities than for movers to more expensive cities, namely:

$$\left.\frac{\partial p_{WTP}}{\partial p_o}\right|_{p_o>p_d} > \left.\frac{\partial p_{WTP}}{\partial p_o}\right|_{p_o<p_d}$$

Formally, the coefficient on city of origin rent should be higher for movers coming from more expensive cities than for movers to more expensive cities. This last prediction highlights a distinctive decoy effect property of salience: in expensive cities where p_d is high, any given price difference is less salient, reducing anchoring to past rents. Loss aversion would predict the opposite effect.

II. Empirical Tests

We use data from the Panel Study of Income Dynamics (PSID), a longitudinal yearly survey on a representative sample of U.S. families. PSID data on housing history is now available from 1983 to 2013, roughly tripling the SL sample (1983-1993).[1] We supplement this data with historical data on median rents at the county level from the Fair Market Rents Dataset.[2] Like SL, we focus

[1] The analysis uses the PSID's Sensitive Data Files. We obtained access to this data under contractual arrangements designed to protect the anonymity of respondents. PSID did not collect data on rent paid during the years 1988 and 1999, so these years are excluded from the analysis. Following SL, we focus on households observed for at least five survey waves and who move cities at least once. Additional information on our data analysis is available upon request. Table A.1 in the Appendix presents some summary statistics for our sample.

[2] Fair Market Rents data are available at https://www.huduser.gov/portal/datasets/fmr.html.

our analysis on Metropolitan Statistical Areas (MSAs), and use the terms city and MSA interchangeably. Median rents are aggregated to MSA level using population weights and all prices are converted to 1999 dollars.

To test predictions 1 to 4 we follow closely SL's approach. Consider a household i that moves in survey year t and is a renter after the move. We take his post-move rent at year t, denoted p_{it}, as a proxy for his unobserved p_{WTPit}. We then run regressions of the form:

(3) $ln\, p_{it} = \beta_o \cdot ln\, p_{o,t_i} + \beta_d \cdot ln\, p_{d,t} + \boldsymbol{\beta_X} \cdot \boldsymbol{X}_{i,t} + \varepsilon_{i,t}$

Let p_{o,t_i} and $p_{d,t}$ denote the median rents in the mover's cities of origin and destination, respectively. While rent levels in the current city are measured in the year of the move, t, rent levels in the city of origin are measured the last year the household lived there.

There are two related econometric concerns: rental quality must be held constant and we must address heterogeneity of households. Like SL, we control for housing quality and household heterogeneity by including in our regressions several controls available in the PSID: household income, family composition, and age and education of head of household. We also control for whether the household previously rented or owned, and for a measure of relative taste for housing, the ratio $p_{i,t_i}/p_{o,t_i}$ of their rent expenditure to the median rent in the city of origin for past renters, and the analogous ratio in terms of house prices for past owners. We also include year fixed effects and a Heckman correction to account for endogenous sorting into renting, as opposed to buying.

We test prediction 1 using all observations of households in the year they move across cities. To test prediction 2 we consider households whom we observe moving within a city after having moved between cities. To test prediction 3 on adaptation through price-similarity, we focus on movers for whom we observe two moves across three cities. We measure rent similarity between the earlier city and destination city by the absolute difference in median rent $|p_d - p_{earlier}|$. We then divide these movers into households for whom price similarity between destination and earlier cities is higher or lower than the median in this sample, and run the regression separately for each group. Finally, we test prediction 4 on asymmetry by dividing the baseline sample (used in Prediction 1) into households who moved to more expensive versus cheaper cities.

Table 1 presents the results. The estimates show the expected positive relation between rent paid and income, family size and local price levels. Intuitively, richer and larger households are likely to rent larger places. The results support predictions 1 and 2, and quantitatively confirm the findings of SL (2006) in our larger dataset. In the baseline case (column 1), the coefficient β_o on

$log(p_o)$ is significantly positive and similar in magnitude to SL's: two otherwise identical individuals whose p_0 differs by one standard deviation differ in their rental expenditures in the same city by 3.4%. Prediction 2 also finds support: when households move again within the same city (column 2), past city rents no longer matter. With the smaller sample size, we cannot conclude that this coefficient is significantly different from the baseline case.

TABLE 1: RESULTS FROM REGRESSION (3)

PANEL A

	Prediction 1: Backward looking reference	Prediction 2: Adaptation from recency
Log(income)	0.253***	0.483***
	(0.0367)	(0.0346)
$log(p_d)$	0.499***	0.583***
	(0.0499)	(0.0744)
$log(p_o)$	**0.163*** **	**0.0723**
	(0.0458)	(0.0557)
Constant	-2.094***	-2.798***
	(0.365)	(0.558)
N	2773	719

PANEL B

	Prediction 3: Adaptation from price similarity		Prediction 4: Asymmetry	
	Dissimilar	Similar	Moving up	Moving down
Log(income)	0.339***	0.223***	0.416***	0.385***
	(0.0486)	(0.0590)	(0.0256)	(0.0229)
$log(p_d)$	0.627***	0.589***	0.524***	0.525***
	(0.0983)	(0.137)	(0.0760)	(0.0783)
$log(p_o)$	**0.221***	**0.173**	**0.0703**	**0.243*** **
	(0.106)	(0.141)	(0.0797)	(0.0744)
Constant	-3.114*	-0.807	-1.999***	-3.065***
	(0.877)	(1.012)	(0.439)	(0.403)
N	257	247	1333	1440

Notes: Results estimated at MSA level. Panel A: Predictions 1 and 2. Panel B: Predictions 3 and 4. Not shown: age of head of household, (age squared)/100, female head, attended college, year fixed effects, inverse Mills ratio, number of adults, number of children, taste proxy $p_{i,t-1}/p_0$. Standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

To test prediction 3, we restrict the sample to households that move twice (columns 3 and 4). As the model predicts, when movers have experienced past rent levels similar to current ones (column 4), the influence of city of origin rent $log(p_o)$ on rental expenditure in the destination city is insignificant. But when movers have not experienced similar rents in the past (column 3), the effect of past rents is larger, and statistically significant. Again, given the small sample, the coefficients are not significantly different from each other.

Finally, in line with prediction 4, the anchoring of rents paid to past rents is driven almost entirely by households that move to cheaper cities, and rent more expensive housing than locals do (columns 5 and 6). Past rents matter much less when households move to more expensive cities. The β_o coefficients are different across the two samples at the 5% significance level.[3]

In sum, the evidence is consistent with the four predictions of the model. Memory-based reference points provide a rationale for anchoring to recent rent levels, previously documented by SL. Adaptation based on rent similarity is a more nuanced prediction, and the evidence is statistically weaker but supportive as well. Finally, we find support for asymmetric reference-dependent valuation. Our model thus generates novel predictions that we tested and confirmed using heterogeneous consumer experiences.

III. Conclusion

The interaction between memory and attention yields reference effects that shed light on observed housing choices of movers. The reference price, or norm, is not rational but is formed using past experiences. Indeed, rational expectations reference points would counterfactually imply immediate adaptation upon learning destination city level of rents. The memory based price norm also differs from a mechanical "backward looking" one because it adjusts through similarity. Because our reference point is situation-specific, adaptation is fast if similar experiences were had even in remote past.

Salience and attention put additional discipline into the context-dependence created by memory, because they describe through well known mechanisms of sensory perception how measurable surprises affect choice. The current analysis is merely a proof of concept. BGS (2019) present a more general model of memory and attention that accounts for a variety of puzzling aspects of choice. The present paper does show, though, that models of choice combining psychologically plausible formulations of memory and perception can help explain field data.

[3] The results of Table 1 are robust to different specifications. Controlling for endogenous selection into renting or for taste for housing, or excluding households who move for housing related reasons, plays essentially no role. Restricting the sample to households who rented *before* the move has little effect, except for prediction 3: the results remain directionally consistent, but the effect on households who experienced dissimilar prices is no longer significant, perhaps due to the much smaller sample size. SL test a version of Prediction 4 and find no asymmetry in their shorter sample.

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