



## Cognitive Shortcuts

### *The Impact of Heuristics on Housing Market Prices*

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#### ABSTRACT

*Reference points have the power to affect the sale price in future due to changes in the purchase price. Reference points are affected by various factors like available market information, market fluctuations, buyers and sellers. Past prices manipulate reference points and information disclosure manipulates reference points. This study tries to investigate the impact of biased references and heuristic thinking on the sale price of the housing market. Regression discontinuity design has been used in this study. This tool helps to compare the sales prices of round number properties with charm number properties. Repeat sales analysis has been used to control the effect of fixed forces and property characteristics.*

*This study shows that if past sale prices of house properties are a round number or multiples of 1000, then future property prices rise with a sufficient premium compared to properties listed below round numbers. It has been estimated through this research using repeat sale analysis from the sample taken from the Gurgaon region of India from 2017 to 2024, shows that behavioural biases in the housing market by revealing that properties with round numbers achieve approx. four per cent increment in future selling as compared to those properties recorded at charm numbers. Increasing public access to information reduces this effect. Fiscal incentives, financial stress, and pricing errors cannot explain the result.*

**Keywords:** Round Numbers, Repeat Sale Analysis, Charm prices, Biases and Pricing Errors

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#### INTRODUCTION

Home is an invaluable asset. Human beings invest their lifetime savings to possess a home. When buy home, it seems like dreams comes true. Buy home is not just investment move but also an emotional action of an individual. This satisfy shelter as well as financial need. The homeowner always wants to sell that house at a maximum price at the time of sale. They are prone to particular bias at the time of sale, known as reference dependence or anchoring bias (Meng, 2023). They use the initial buy price as a reference point and don't want to sell below this reference price because they consider it a loss (Anenberg, 2011; Engelhardt, 2003). In this research, the focus has been diverted to the initial price paid used as a reference point cause of creating anchoring bias in the property market. The intention to study this topic has drawn from growing evidence

of inattention towards transaction details from recent research (Wang et al., 2021, Turen, 2023, Fritze et al., 2024, Chen et al., 2024). Perception of people about previous prices is affected by inattention as demonstrated by evidence that distorts reference price (Repetto et al., 2020). Inattention affects how people perceive past sale prices. This distortion converts a small gap in the acquiring price at the time of purchase to a significant gap in the sale price achieved in future.

Attention is a must to explore all the aspects of something someone buys. However, very few people pay full attention to all aspects of a product when buying (Mogg and Bardly, 2016). Attention is minimal and buyers use it selectively. This can cause heuristic and cognitive shortcuts when making buying decisions. Left-digit bias is the most prominent form of inattention, where people focus more on the left digits

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of any value and ignore the right digits (Korvorst and Damian, 2008; Poltrock and Schwartz, 1984). Round numbers are perceived as higher than their actual value and charm numbers are perceived as lower than their true value because of heuristic and cognitive bias. This bias is known as reference dependence bias. This bias greatly impacts the real estate market because property value usually ranges in six digits. This means the value of money of property is being overlooked. The framework has been designed to interpret empirical findings regarding reference dependence and left-digit bias through repeat sales in the property market. This research analyses the impact of the period a property is listed in the market before the sale to understand who is more affected by left digit bias either seller, buyer or both. If the seller is affected by left digit bias, the round number property will stay longer in the market because a seller will wait for a premium price. If the buyer is more affected by this bias, the property will list for a shorter period. Buyers will be attracted towards round number properties due to which property will sell faster because the buyer will agree to pay the asked price by the seller. However, if both parties of the transaction are affected by this bias, its impact is ambiguous because it can either balance this distortion or enhance it.

This research is an endeavour to test whose inattention is driving the result. To test this notion empirically, the transaction price of properties with round numbers is compared with charm number properties. This technique is similar to regression discontinuity design. Left most digits are considered as a treatment of the previous price of properties. The round and charm price properties are identical in value but they differ in terms of more columns in the most left digits. Round number previous price properties are in the treatment group and charm number previous price properties are in the control group. Both groups' future sale prices highlight that property prices are not affected by their previous price but are distorted by left-digit bias.

This analysis utilises the house transactions of Gurgaon region of India from 2017 to 2024. This study compares the properties sold at round numbers in multiples of 1000 with those sold at charm numbers within multiples of 1000. The researcher found that after controlling property characteristics and the effect of various fixed factors, the property valued at round numbers sold at a four per cent premium. The effect size grows with the

roundness level. For multiples of 10000, the increment is 4.3%, for multiples of 100000, the premium per cent is 6.5%. The effect size reduces over time. It was 9.8% in the year 2017 and now it is 4.3% in 2024, which is consistent with the assumptions of inattention theory that people become less attentive towards such type of information over time, which reduces this bias.

The robustness of the findings has been evaluated. Before 2016, Real estate was not centrally regulated in India. RERA (Real estate regulation act) has come with the latest revolutionary reforms, where all transaction data related to property have been centralised. Before 2017, Property prices were bunched below or equal to the threshold limit. All transactions around the threshold limit have been removed to reduce the estimation bias. The findings show that tax consideration is not the cause of price premiums.

Another property characteristic that can cause this bias is that properties previously transacted at round numbers have high financial constraints, due to which their reservation price is also high. This high reservation price converts into a high transaction price compared to properties previously transacted at charm numbers. The loan-to-value ratio has been calculated to measure the financial constraints of the seller to rule out this possibility.

A question emerges whose inattention became the cause of this distortion either the seller or buyer? The researcher collects data about list price, online page review and how long a property stays in the market. The pattern of similar discontinuity not only arises in the list price but also persists in the final sale price. This shows that left-digit bias affects the seller's decision about the list price. The findings of the result show that the seller and buyer both are affected by left-digit bias. This research works on four important pillars. First, it explains the power of numbers. The magnitude of power attracts attention but the way numbers represent or format of numbers also plays an important role. Second, it explains the process of reference formation. It is assumed the location of the reference point is fixed as one's current perception. It has been observed that reference points are affected by various other factors like aspirations, expectation level, and the status quo. The research shows that reference points can be distorted by heuristics such as left digit bias. Third, this

research adds in the scarce literature on inattention. Inattention is a phenomenon, where individuals focus less on important information or avoid it. This research is an endeavour to highlight how inattention affects individuals' decision-making process and financial behaviour. The novelty of this study is that it focus of reference dependence observed through repeat sales analysis so that impact of latent characteristics of housing on its pricing can be controlled.

The classical theories postulate house prices to be rational and determine based on structure, location and other rational factors. But with time, the effect of behavioural biases has been observed on housing prices. Many studies showed this impact through their research (Arbel et al., 2014, Liu et al., 2015). This study is an addition to the existing literature specifically focusing on anchoring bias's impact on house prices.

## LITERATURE REVIEW

The previous price serves as a reference point in the secondary housing market for both seller and buyer in the decision-making process. This effect is known as loss aversion and reference dependence bias (Genesove and Mayer, 2001). Sellers decide the list price based on the previous price they paid when they acquired that property (Northcraft et al., 1987). If the market price goes below the last price, the seller fixes the list price above the market price value because of fear of loss. When the current market price is above the previous price, sellers tend to set a lower price than the previous price because they have a feeling of gain when the market price is high (Talbot and Schneider). They accept lower reservation prices due to this reference dependence otherwise they would not accept this price (Bushong and Bartsch, 2023).

The evaluation of home buyers is affected in three different ways through property previous prices. Buyers measure quality through the previous selling price. They consider the previous selling price of a property as a signal of quality (Fluet and Garella, 2002, Erdem et al., 2008). They are attracted to buying properties sold at higher prices in the past. Properties sold at high prices have more viewers and bidders at the time of auction, which causes a higher final transaction price. Second, The decision-making process of individuals is affected by an arbitrary value known as an anchor.

They are restricted to move from that particular value fixed by them arbitrarily (Tversky and Kahneman, 1974). The Previous sold price of a property is considered by buyers when they bid for a property. If the previous price is high, they bid high or vice-versa. Third, buyers consider the list price to be an anchor. A positive relation between list price and sales price has been observed. It has also been observed that if sellers increase the list price due to reference dependence, a few parts of its premium pass onto the final transaction price because buyers take this list price as an anchor. All three effects demonstrate that reference dependence influences buyer willingness to pay.

Because of left digit bias, the perception of the original purchase price gets distorted, leading to an undue increase in perceived reference prices. This happens because people read digits from left to right and pay more attention to left-digit numbers. Left digits are perceived with full attention and the remainder digits on the right side are perceived with less or zero attention (Chava and Yao, 2017). The round numbers have perceived value equal to true value because round numbers like 1000 have zero remainder. On the other hand, charm values below the round numbers have large remainder values and consequently have a large perception bias. This bias creates an imbalance in the perceived values of investors.

## Research Gap

The previous studies conducted on heuristic biases in different sectors but there is a dearth of studies focusing on heuristics in housing market specifically on anchoring and adjustment bias. This study is an endeavour to find out the effect of anchoring derive due to charm numbers in property market and periodic adjustment in it. This study will help in reducing future bubbles and market anomalies fruitful for different stakeholders of property market.

## Market Equilibrium

This study assume that there is a simple linear utility function to show how reference prices impact equilibrium sales prices and sales time, as well as the results brought on by the left-digit bias. Assume that prospective sellers get utility if they do not sell their houses during this time and receive  $p + \lambda(p - r)$  if they sell for price  $p$ , where  $r$  represents the reference price

and  $\lambda$  indicates the degree of bias.  $ps^* = 1/(1 + \lambda)^* v_{\{s\}} + \lambda/(1 + \lambda)^* r$  will be the reservation price. In  $r$ , it is rising. Assume that if a buyer purchases the property at price  $p$ , their utility is  $vb - p - \gamma(p - r)$ ; if not, it is 0. Then,  $pb^* = 1/(1 + \lambda)^* v_{\{b\}} + \lambda/(1 + \lambda)^* r$  is the maximum amount the investor will be ready to pay.

Let's say a buyer turns up with  $vb$  and just bids  $p^*b$ . When round numbers are crossed, the ultimate price conditional on a sale rises in  $r$ , with discontinuous effects (particularly so for larger rounded values). This leads to the first prediction: properties with round prior prices have higher prices for later sales than comparable properties with prior prices at nearby charm values; if all else is equal, the more rounded the prior prices, the bigger the price premium in subsequent sales.

If purchasers would find a sales price of ₹30,00,000 to be much more valuable in the future than ₹29,99,999, then round prices ought to be the more typical equilibrium results. To reap the benefits in the future, buyers can only spend a little more money. Why do charm sales pricing still exist? A large number of consumers may be unaware of left-digit bias and are not prepared for this potential sales impact. They like being able to claim that the house cost them less than ₹50,00,000. Instead of the actual value, the leftmost digits go straight into their utility function.

Sellers actually have to choose between getting the best price for their house and taking a long time to obtain it. We would anticipate higher prices but longer time-on-market if left-digit bias only affects the seller's valuation (i.e., by raising their reservation price) throughout the process. On the other side, we would anticipate greater prices and a shorter time on market if it simply raises the buyer's willingness to pay. Higher selling prices but unclear impacts on time-on-market are what we would anticipate if the truth is somewhere in the center. Therefore, the second prediction is that if sellers are inattentive,  $r$  will have a positive influence on the likelihood that a transaction will not occur; if buyers are inattentive, it will have a negative effect; and if both are inattentive, it will have an ambiguous effect.

### Discontinuities Estimates

The equation mentioned below is used to apply regression discontinuity.

$$\ln P_{ijst} = \alpha_0 + f(\ln P_{is}) + \sum_{K=3} \alpha_k D [50 P_{is} \geq j \times 10,000] + X'\beta + \delta_t + \varphi_j + e_{it} \quad \dots \text{(Eq. 1)}$$

Dependent variable = Current price log value of House (i), District (J), Previously transacted time (s) and Current time (t); F is the flexible function of (Pis) log value of previous price; D = Indicator variables, X = Dummy Variable;  $\delta_t$  = Time fixed effect for the year of transaction;  $\varphi_j$  = District fixed effect;  $\alpha$  = Constant;  $e_{it}$  = Error term

The function ( $P_{is}$ ) help to capture the pattern of current house price based on previous price by considering it as an anchor smoothly (Athey and Imbens, 2017). To know whether the previous prices are passing the round number, the variables relevant for study named as D are used. The round number is multiples of 10000 is used for this research paper. The discontinuous jumps at various multiples are expected to be positive and captured by alpha parameters from 1 to 50. Phi symbol is used to absorbed locational impacts and unobserved time-invariant property features that are similar among properties in the same district. The property characteristics are described in Table 2 in the form of dummy variables which indicates whether there is a garden, number of rooms, any school located nearby, location attributes and whether it is freehold or leased?

### Repeat Sales Approach

There is an issue with equation one that omitted variables confound with the variables studied named as potential bias (Ben-David, 2011). To overcome this issue, this research has utilised repeat sales analysis (Agarwal et al., 2015). The dependent variable for this purpose is the difference between house prices between two continuous transactions of the same property. By doing this the effect of the property specific characteristics which not change with the time including unobservable ones can be removed so that the effect of other relevant variables can be visible clearly. For this analysis equation mentioned below is used where the price difference of property  $i$ , current transaction time  $t$  and previous time  $s$  is represented as:

$$\ln P_{it} - \ln P_{is} = \ln (P_{it}) = \alpha_0 + \alpha_1 Round_i + X'\beta + \delta_s + \delta_t + \varphi_j + \varepsilon \quad \dots \text{(Eq. 2)}$$

Round number = 1, charm Number = 0

The new variable in this equation is round number which will indicate whether the previous price is charm or round number?

## DATA COLLECTION

In India, most houses are listed under RERA (Real Estate Regulation Agency). This means that it is a single agency in charge of all the activities of a particular region's houses from the time of listing till it's sold or withdrawn. The agents collect and analyse property information, set list prices with sellers, and advertise it for sale on their website portal. Then they search for potential buyers by allowing them to view their website and ask them to make an offer if they are interested in buying that property. The buyer usually gets the property based on their bid price. The buyer with the highest bid gets the property. But seller decides their buyer not just on a bid price basis but also considering other factors like a buyer is acquiring in cash or credit. The list price is not a reservation price. It is a price hoped by seller to achieve approximately. The final sale price can be higher or lower than the list price depending on the market conditions, location and property quality. Many websites are providing free real estate data like realtor.com, Zillow and Redfin etc. The data has collected from these websites. Data set contain property address, pincode, transaction price and transaction dates along with property type.

RERA provides only limited data, so this study used two other websites Zillow and Redfin. In this study,

the researchers have merged these websites dataset with the property characteristics obtained from RERA website by either pincode number or exact address including apartment number. The exact matching was possible through house number or house name. Second method has used for matching is apartment number, when property has been divided into separate units. 30.5 percent repeat sales have remained after this match.

## RESULTS

Table 1 shows descriptive statistics of RERA data (R) and Matched data of Zillow and Redfin (ZR) with RERA in column 1 and column 2. First two rows shows number of sales and number of properties to display repeat sales. The number of properties higher than number of sales.

Nominal home prices are rising over time, as evidenced by the fact that repeat sales prices are typically greater than prior prices (about 1.6 times for mean values). For a single property, the average time between two consecutive sales is six years. A property must be posted for sale at least once in order for a transaction to be included in the matched sample. Consequently, there is an inevitable bias towards recent transactions in the matched sample. The matched sample had higher sales prices than the RERA sample, as seen by the mean sales price in Table 1. Charm-round couples are equally dispersed across all price levels, hence the high cost does not pose any issues for this

**Table 1:** Descriptive Statistics

	<i>(1) Sales with Previous Purchase in 2017- 2024 (R)</i>		<i>(2) Sales with Previous Purchase in 2017–2024 (R – ZR matched)</i>		<i>(3) Local Linear Sample</i>		<i>(4) Zillow Sample, 2017-2024</i>	
Sales (N)	11,44,572		3,62,267		3,11,181		43,220	
Properties	7,48,872		2,22,123		2,02,114			
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
Current sales price (₹)	2,95,164	1,92,103	3,19,810	1,94,381	3,21,136	1,94,885	4,57,034	2,26,391
Previous sales price (₹)	1,75,258	1,04,273	1,84,498	1,03,327	1,88,999	1,03,224	2,21,485	1,00,692
Holding period (year)	5.88	4.07	6.53	4.35	6.25	4.39	10.52	4.78
Freehold	0.43	0.49	0.56	0.5	0.57	0.5	0.66	0.47
<i>Property Type</i>								
Flat	0.56	0.5	0.42	0.49	0.38	0.48	0.41	0.49
Terraced	0.28	0.45	0.37	0.48	0.42	0.49	0.33	0.47
Semidetached	0.13	0.33	0.17	0.37	0.17	0.37	0.21	0.41
Detached	0.03	0.17	0.04	0.19	0.04	0.19	0.05	0.22
Other	0	0.04	0	0.03	0	0.03	0	0.03

Parking			0.2	0.4	0.19	0.39	0.23	0.42
Garden			0.43	0.49	0.42	0.49	0.43	0.5
Patio			0.02	0.13	0.02	0.13	0.01	0.12
No. of Bedroom			2.52	1.03	2.55	1.04	2.67	1.03
Time on the market (day)							292.68	303.21
Total page views							1,066.86	1,146.24

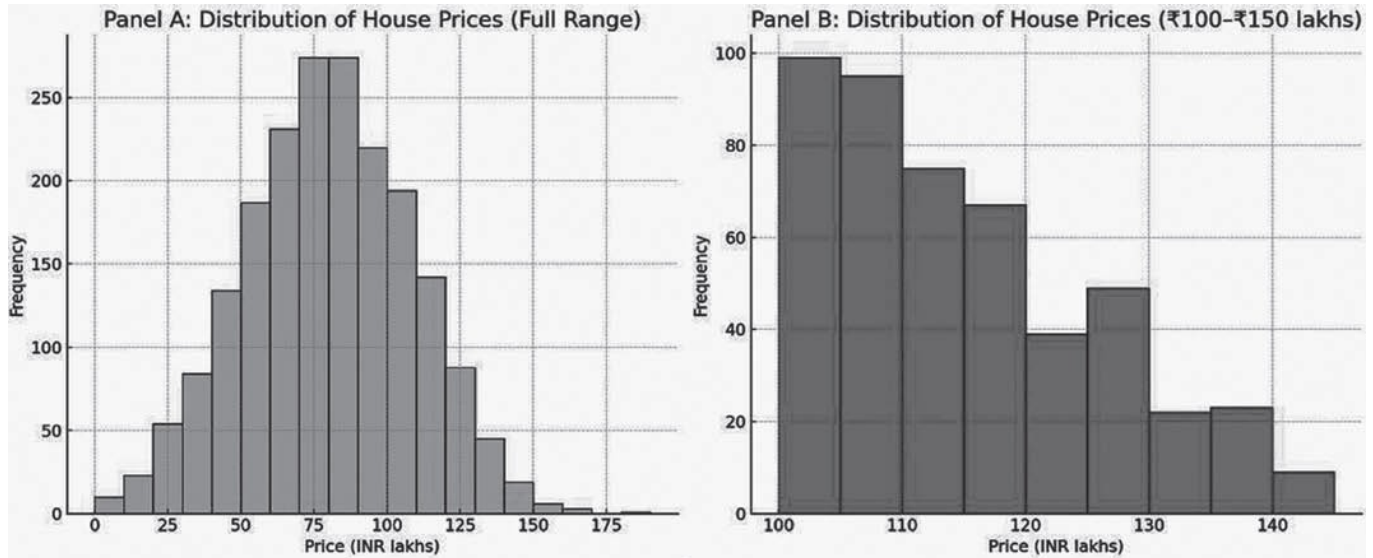


Figure 1: Graphical Representation of the Data for Gurgaon Real Estate Prices (2017–2024)

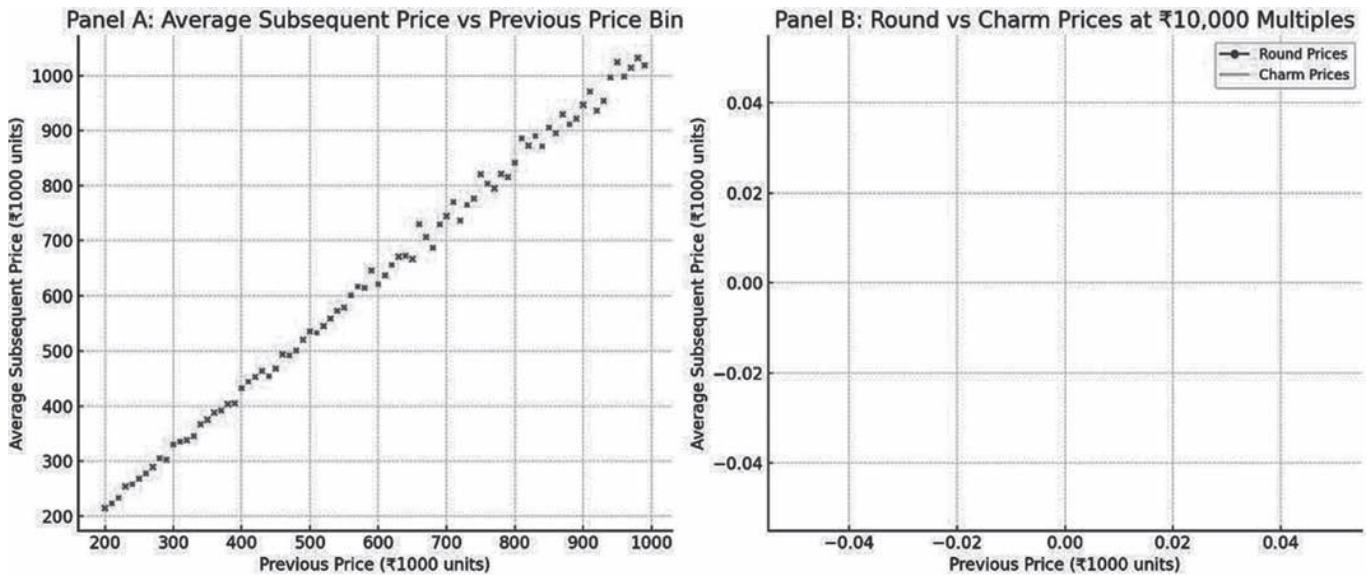


Figure 2: Graphical Presentations of Discontinuity

study. In the combined sample, flats and leaseholds are underrepresented. The primary cause is that, when they were new-build homes, developers or real estate agents sold the apartments—the majority of which are also leaseholds—directly rather than listing them on real estate websites. As a result, there is a small chance that they are listed in RERA’s records.

Figure 1 is a graphical representation of the data for Gurgaon real estate prices (2017–2024). Panel A Shows the distribution of house prices across the full range, in multiples of ₹10 lakhs. Panel B Focuses on house prices between ₹100 and ₹150 lakhs, with multiples of ₹5 lakhs.

**Table 2:** Baseline Effect Size

		<i>Estimates</i>					
		<i>-1</i>	<i>-2</i>	<i>-3</i>	<i>-4</i>	<i>-5</i>	<i>-6</i>
Round		0.006***	0.053***	0.040***	0.041***	0.043***	0.044***
		-0.002	-0.001	-0.001	-0.001	-0.001	-0.001
Property characteristics				√	√	√	√
Fixed effects							
Sale year District							
Magnitude							
District × sale year			√	√	√		
Sale year × month				√			
					√	√	√
						√	√
							√
Observations	3,11,181	3,11,181	3,11,181	3,11,181	3,11,181	3,11,181	3,11,181
R-Squared	0	0	0.721	0.74	0.793	0.81	0.818

*Notes:* The estimates based on Equations (2) for the entire sample are shown in this table. Standard errors are grouped at the property level, and all regressions are OLS estimates. The log of the difference between the present and previous prices of homes is the dependent variable. The independent variables include property characteristics, district fixed effects, previous and current year fixed effects, magnitude of previous price fixed effects, two-way fixed effects of districts and sales year (previous and current), and the dummy variable Round, which equals one if the previous purchase price was a multiple of 1,000.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

**Table 3:** Effect Size in the Doughnut Sample

	<i>-1</i>	<i>-2</i>	<i>-3</i>	<i>-4</i>
Round	0.046***	0.047***	0.043***	0.043***
	-0.001	-0.001	-0.002	-0.002
Round × 5k-multiple			0.002	0.003
			-0.003	-0.003
Round × 10k-multiple			0.001	0.001
			-0.003	-0.003
Round × 50k-multiple			0.012*	0.012*
			-0.005	-0.005
Round × 100k-multiple			0.025***	0.026***
			-0.005	0.003
Property characteristics	√	√	√	√
Fixed effects	√	√	√	√
Magnitude	√	√	√	√
District × sale year		√		√
Sale year × month				
Observations	2,92,766	2,92,766	2,92,766	2,92,766
R-Squared	0.795	0.814	0.814	0.82

Figure 2 is Graphical Presentations of Discontinuity. Panel A shows the average subsequent price on y-axis are shows against previous price blocks on x-axis in ₹1,000 units. The dot sizes are proportional to the number of properties in each block. Panel B shows the Comparison between the average subsequent prices for

“round” (divisible by ₹10,000) and “charm” (ending in ₹9,000) previous prices at each ₹10,000 multiple.

Different dependent variables have regressed as shows in column 1 with different variables of interest. Property attributes and fixed effects has used in Model

**Table 4:** Effects on Sales Outcomes

Dependent Variable	No. of Observations	Model 1 Coef. Round	Model 2 Coef. Round
ln(sales price – previous price)	43,220	0.039***	0.039***
		-0.003	-0.003
ln(list price – previous price)	43,220	0.043***	0.043***
		-0.003	-0.003
Time on the market	30,876	1.223	1.562
		-2.992	-2.989
Total page views	42,388	35.618**	34.663
		-18.105	-18.108
Property Characteristics		√	√
Fixed Effects		√	√
Charm list Price			√

1 and when list price is charm number then one new dummy variable which is equal to 1 has added.

## CONCLUSION

House buying decision is one of the important decisions of a life because it requires a huge proportion of wealth. The study highlights that even the housing purchase decision is very important but cognitive short cuts impact the decision and becomes the cause of avoiding critical information. Reference points specifically previous prices influence buyers and sellers' decision. Even a minor increase in previous price which cause changes in left digit number has a significant impact on buying and selling perceptions. This changed perception creates new reference point. In subsequent transactions, this left-digit bias results in a price premium, demonstrating that even little numerical changes can have significant effects in high-price marketplaces. There are two primary rounding heuristics has found: Rounding-by-Chop: The process of truncating digits to simplify numbers. Rounding to the closest number that is easy to understand is known as "rounding-to-the-nearest." The study found rounding by chop is more prevalent and the cause of price error in housing market. This study emphasizes how crucial it is to understand cognitive heuristics while making significant financial decisions and poses the question of whether increased knowledge or tools could lessen these biases.

## FUTURE SCOPE

This study has limited to a specific time period and covered only a specific region of India. The study has few limitations and it cannot explore all the questions related to this topic. Future studies can explore the relation between inattention and characteristics of property. Do mathematical models have power to change this relationship? Do players good with numbers are at better position to overcome with left digit bias? Does first time property buyers are more attentive than professional or repeated buyers?

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